Radiological Health Data

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VOLUME IV, NUMBER 1

JANUARY 1963

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

Radiological Health Data is published by the Public Health Service on a monthly basis. Data are provided to the Division of Radiological Health by other Federal agencies, State health departments, and foreign governments. Pertinent original data and interpretive papers are invited from investigators. Accepted material will be appropriately credited. The reports are reviewed by a Board of Editorial Advisors with representatives from the following Federal agencies:

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Atomic Energy Commission
Department of Defense
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For further information on any subject reported in this issue, readers are referred to the contributors indicated in article headings.

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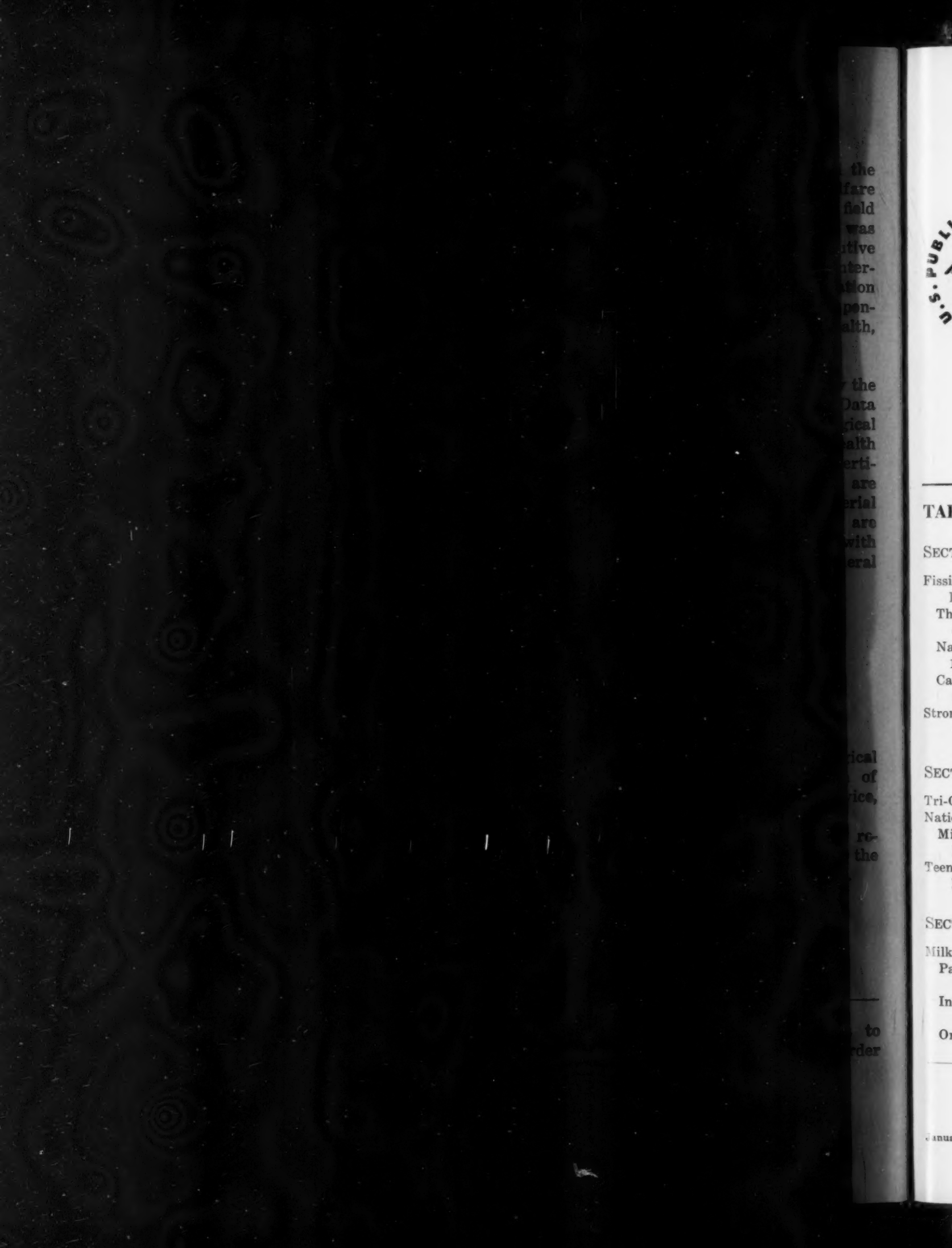

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service • Division of Radiological Health

SECTION I.—AIR AND FALLOUT

Fission Product Beta Activity in Airborne Particulates and Precipitation

Surveillance of gross beta activity in air and precipitation provides quick and sensitive detection of fission product activity fluctuations in the environment. Although this information alone does not permit direct evaluation of biological effects, it is widely used in warning systems and programs for investigating patterns and trends in fallout distribution. In this issue, September results from several of these surveillance programs appear under the following titles: "The 80th Meridian (West) Sampling Program," "National Air Sampling Network," and "Canadian Radioactive Fallout Study Program." The September data from the Radiation Surveillance Network were published in the December 1962 *Radiological Health Data.*

THE 80TH MERIDIAN (WEST) SAMPLING PROGRAM
September 1962

U.S. Naval Research Laboratory

Radioactivity measurements of surface air samples collected at various sites near the 80th Meridian (West) have been made since 1956. Sampling locations are shown in figure 1. This program is operated by the U.S. Naval Research Laboratory (NRL)* with the cooperation of interested agencies of the United States, Canada, Ecuador, Peru, Bolivia, and Chile, which collect the samples and forward them to NRL for analysis. Partial financial support of

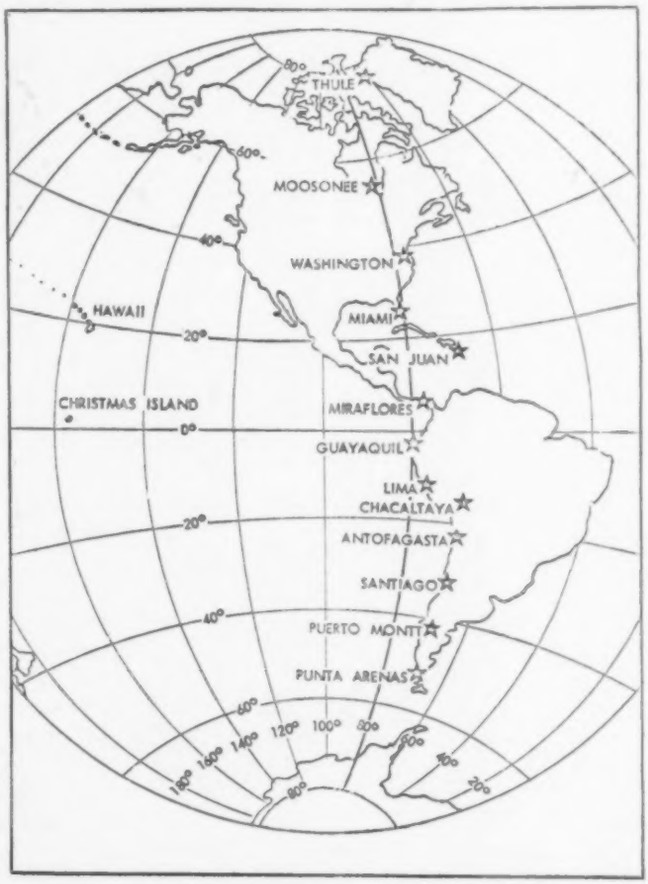

FIGURE 1.—ATMOSPHERIC RADIOACTIVITY SAMPLING STATIONS NEAR THE 80TH MERIDIAN (WEST)

* Editor's note: Effective January 1, 1963, administration of the 80th Meridian (West) Sampling Program was turned over to the Health and Safety Laboratory, Division of Biology and Medicine, AEC, by the U.S. Naval Research Laboratory.

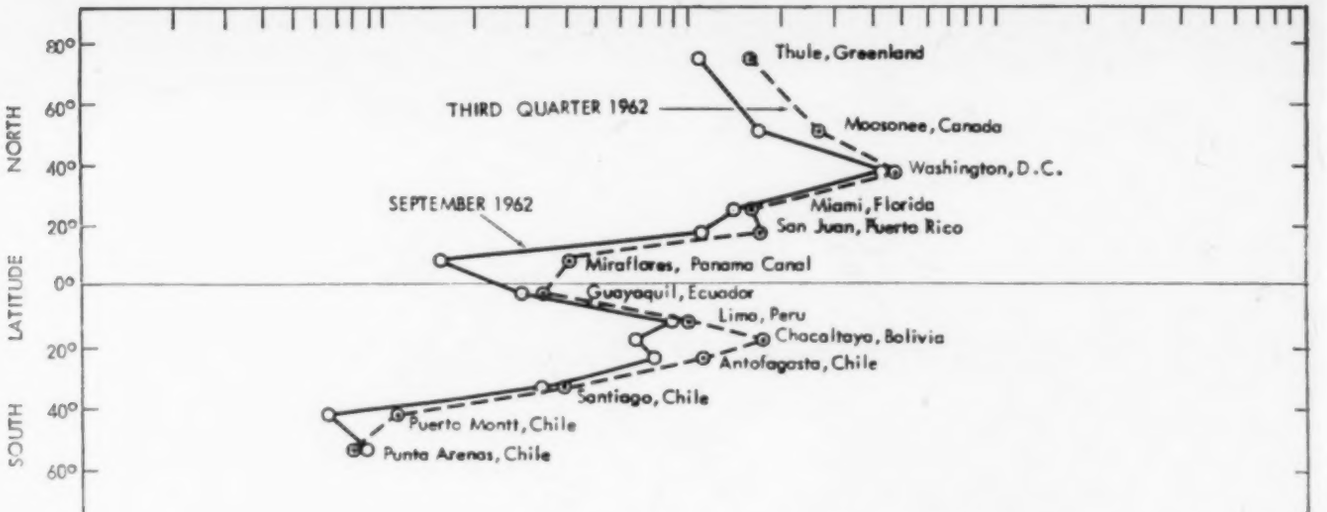

FIGURE 2.—PROFILE OF BETA ACTIVITY, AVERAGE MEASUREMENT OF SURFACE AIR AT STATIONS NEAR THE 80TH MERIDIAN (WEST) SEPTEMBER 1962

this program is provided by the Division of Biology and Medicine, U.S. Atomic Energy Commission.

The sampling procedure involves drawing air continuously for a 7–day period, at a rate of approximately 1200 cubic meters per day through an 8–inch diameter, high-efficiency filter, using a positive displacement blower.

TABLE 1.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, NRL, SEPTEMBER 1962[a]

[Average concentrations in μμc/m3]

September 1962	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador	Miraflores, Panama Canal Zone	San Juan, P. R.	Mauna Loa, Hawaii[b]	Miami, Florida	Washington, D. C.	Moosonee, Canada	Thule, Greenland
1 2 3	0.030	0.060	0.430	0.900	1.26	0.954	0.404	0.167	1.41	[c]—	0.639	5.00	2.60	1.45
4 5 6 7 8 9 10	0.080	0.031	0.279	0.756	0.792	1.00	0.342	0.205	—	1.50	1.80	4.26	1.63	0.268
11 12 13 14 15 16 17	0.099	0.094	0.222	0.625	0.621	0.828	0.316	0.146	1.14	1.02	2.12	4.99	0.932	0.507
18 19 20 21 22 23 24	0.055	—	0.371	0.697	0.342	0.774	0.273	0.090	1.14	1.04	0.932	4.03	1.84	1.21
25 26 27 28 29 30	0.139	—	0.398	0.868	0.630	0.828	0.122	0.157	0.77	0.868	0.860	2.19	1.87	2.06
Weighted average	0.085	0.063	0.326	0.747	0.662	0.868	0.282	0.151	1.08	1.11	1.36	4.04	1.66	1.02

[a] The average concentration determined from a given sample is placed at the center of a rectangle which indicates the length and dates of the sampling period. Station averages for the month were determined by weighting the sample average according to the number of days in the sampling period or that portion of the sampling period occurring in September 1962.

[b] Mauna Loa data have been included for comparison with Chacaltaya, Bolivia. Both are high-elevation stations (3400 and 5200 meters) and about equally distant north and south of the equator.

[c] Dash indicates samples were not received.

After the 7–day period, the filter is removed and forwarded to NRL for assay of gross beta activity. A minimum of 2 weeks after collection is allowed for decay of short-lived radionuclides. Data are not extrapolated to time of collection.

NATIONAL AIR SAMPLING NETWORK
Third Quarter 1962

Division of Air Pollution, Public Health Service

The National Air Sampling Network was organized in 1953 to secure basic data on the nature and extent of air pollution throughout the United States, and to detect trends in levels of pollution with respect to time, location, population density, climate, and other factors associated with air quality. The network stations are manned by cooperating Federal, State, and local agencies. All samples are analyzed at the Network laboratory in Cincinnati, Ohio.

The current basic network consists of 110 sampling stations operating every year in 73 large cities and 37 nonurban areas. In addition to these every-year stations, 130 cities have stations which operate every other year. Thus, there are 240 sampling stations in all, of which about 175 are active in any given year.

Continuous 24–hour samples of suspended particulate matter, representing approximately 2,000 cubic meters of air, are collected on glass fiber filters on a biweekly random sampling schedule. The analyses of these samples include the measurement of total quantity of suspended particulate matter, the benzene soluble organic matter, and gross beta radioactivity. Selected samples are analyzed also for nitrates, sulfates, and a number of metals.

Gross Beta Activity in Air

Gross beta activity data, by States for 1953 through 1958, were submitted by the Division

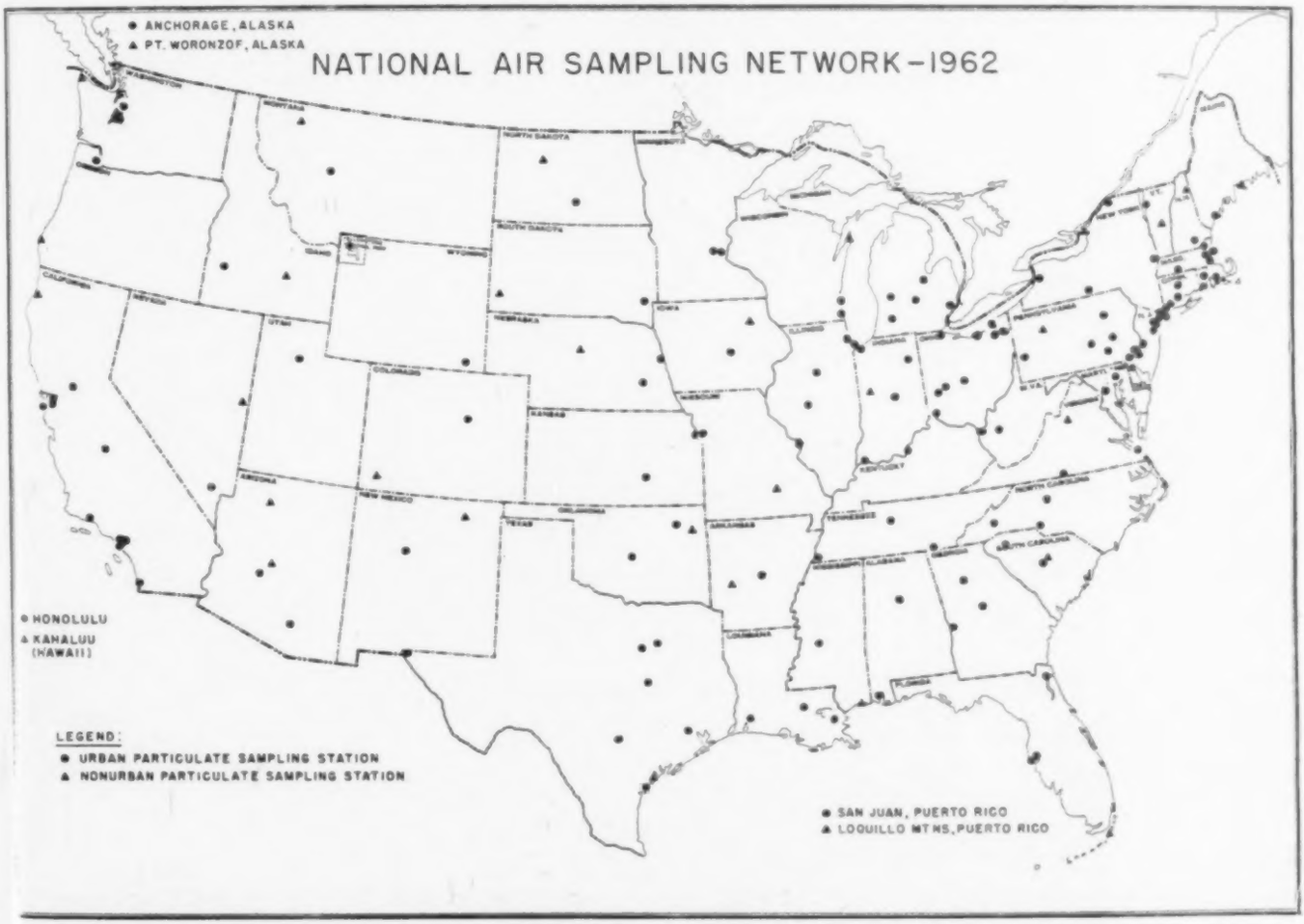

FIGURE 3.—NATIONAL AIR SAMPLING NETWORK SAMPLING STATIONS, 1962

TABLE 2.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, NASN, THIRD QUARTER, 1962

[Concentrations in pc/m³]

Station location		No. of Samples	Minimum	Maximum	Average
Alabama:	Birmingham	7	0.3	11.6	4.7
	Mobile	6	1.1	14.2	4.7
Alaska:	Anchorage	5	0.2	3.2	1.4
	Pt. Woronzof*	5		2.8	1.7
Arizona:	Grand Canyon Pk.*	6	1.2	14.2	6.9
	Maricopa Co.*	6	0.9	6.2	3.6
	Phoenix	7	0.7	9.2	4.1
	Tucson	6	2.5	3.6	3.0
Arkansas:	Little Rock	6	0.2	10.5	3.9
	Montgomery Co.*	5	0.3	4.6	2.7
California:	Burbank	6	2.7	4.5	3.5
	Fresno	6	2.4	8.9	4.9
	Humboldt Co.*	3	0.2	1.4	0.8
	Los Angeles	6	1.2	4.8	2.7
	Oakland	6	1.1	4.1	2.5
	Pasadena	6	1.8	5.7	3.2
	Richmond	5	0.1	2.1	0.9
	Sacramento	7	1.3	5.3	3.1
	San Diego	5	1.1	4.3	2.7
	San Francisco	7	0.5	4.2	1.7
	Santa Barbara	6	0.7	6.3	2.4
Colorado:	Denver	7	1.4	14.3	4.6
	Montezuma Co.*	5	2.1	11.8	4.8
Connecticut:	Bridgeport	6	0.4	7.1	4.1
	Hartford	7	0.3	5.9	2.6
	New Haven	6	0.7	5.6	3.6
	Stamford	7	1.1	3.6	2.3
Delaware:	Kent Co.*	6	0.3	7.1	3.3
	Wilmington	6	0.9	3.8	2.8
District of Columbia:	Washington	6	2.8	14.0	5.8
Florida:	Florida Keys*	6	0.5	3.2	1.5
	Jacksonville	6	1.0	5.5	2.4
	Orlando	4	1.5	1.9	1.7
	St. Petersburg	7	1.0	7.2	2.9
	Tampa	7	0.6	6.3	2.6
Georgia:	Atlanta	6	0.9	4.6	2.7
	Columbus	6	1.5	10.2	5.4
	Macon	5	1.7	3.2	2.4
Hawaii:	Honolulu	7	0.7	4.6	1.7
	Kahalun*	5	1.0	2.6	1.9
Idaho:	Boise	6	2.9	11.6	6.0
	Butte Co.*	7	2.4	11.0	5.9
Illinois:	Chicago	7	1.1	5.5	3.2
	Cicero	4	1.3	5.7	3.6
	Peoria	6	1.7	5.3	2.9
	Springfield	5	1.9	5.9	3.1
Indiana:	East Chicago	5	2.0	5.1	2.9
	Evansville	5	0.2	5.1	2.6
	Fort Wayne	6	1.7	4.9	2.8
	Gary	5	1.5	3.3	2.6
	Indianapolis	6	1.8	4.7	2.8
	Parke Co.*	6	1.9	6.6	3.4
Iowa:	Delaware Co.*	4	1.8	2.6	2.2
	Des Moines	6	1.7	8.2	3.9
Kansas:	Kansas City	5	2.3	7.0	5.5
	Wichita	6	1.7	5.8	2.8
Kentucky:	Louisville	5	1.8	6.3	3.2
Louisiana:	Baton Rouge	6	1.2	4.3	3.0
	Lake Charles	6	0.5	5.5	2.6
	New Orleans	6	0.7	3.8	2.1
Maine:	Acadia Nat. Pk.*	4	0.2	3.0	2.1
	Portland	5	0.9	5.4	3.2
Maryland:	Baltimore	6	3.8	7.6	5.2
	Calvert Co.*	6	2.4	5.4	3.7
Massachusetts:	Boston	5	1.0	5.6	3.4
	Fall River	7	0.1	9.0	3.7
	Lawrence	6	0.5	9.9	4.2
	Lynn	6	0.8	9.7	3.8
	Quincy	5	0.4	6.4	3.5
	Somerville	5	0.3	6.0	4.0
	Springfield	7	2.3	8.9	4.8

* Nonurban station.

TABLE 2.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, NASN, THIRD QUARTER, 1962—Con.

[Concentrations in pc/m³]

	Station location	No. of Samples	Minimum	Maximum	Average
Michigan:	Detroit	5	1.8	4.4	3.2
	Grand Rapids	5	0.7	4.3	2.4
	Kalamazoo	7	1.8	5.2	3.9
	Lansing	6	1.2	11.3	4.3
	Saginaw	6	2.2	6.5	4.1
Minnesota:	Minneapolis	7	1.8	6.4	3.8
	St. Paul	7	1.8	13.8	5.5
Mississippi:	Jackson	6	0.8	14.2	3.7
	Jackson Co.*	4	0.4	2.7	1.5
Missouri:	Kansas City	5	2.0	8.4	6.3
	Shannon Co.*	4	1.7	10.6	6.4
	St. Louis	7	1.9	6.2	3.7
Montana:	Glacier Nat'l. Pk.*	6	0.4	3.0	1.9
	Helena	6	4.5	12.0	6.4
Nebraska:	Lincoln	6	0.9	4.9	2.7
	Omaha	5	2.5	6.1	3.9
	Thomas Co.*	6	1.8	6.5	3.6
Nevada:	Las Vegas	2	2.8	15.7	9.3
	White Pine Co.*	5	3.5	7.4	6.3
New Hampshire:	Manchester	4	1.1	4.3	3.1
	Coos Co.*	5	1.8	5.0	3.3
New Jersey:	Camden	6	2.5	5.6	3.8
	East Orange	4	2.9	4.6	3.8
	Elizabeth	6	1.7	8.1	4.1
	Newark	6	2.0	6.2	3.5
	Trenton	4	2.1	5.4	3.7
New Mexico:	Albuquerque	6	1.9	4.3	3.2
	Colfax Co.*	6	1.4	6.3	3.0
New York:	Cape Vincent*	6	1.8	4.9	3.5
	Glen Cove	4	1.1	5.3	2.8
	Massena	6	1.4	5.3	2.7
	New York	5	3.1	6.5	4.8
	Niagara Falls	3	1.5	4.7	2.6
	Rochester	6	0.8	3.8	2.1
	Troy	4	2.1	6.0	4.2
North Carolina:	Asheville	7	1.5	8.5	5.0
	Cape Hatteras*	6	2.2	6.4	4.1
	Charlotte	7	1.2	6.5	3.9
	Winston Salem	7	2.8	7.7	5.7
North Dakota:	Bismarck	6	2.9	7.1	4.6
	Ward Co.*	7	2.5	6.3	3.8
Ohio:	Akron	7	0.7	8.1	3.2
	Cincinnati	7	2.2	9.6	4.5
	Cleveland	6	2.0	9.7	5.7
	Columbus	6	2.5	6.0	4.2
	Dayton	7	1.0	4.6	2.8
	Lorain	6	2.3	4.3	3.0
	Springfield	6	1.5	6.3	3.4
	Toledo	7	2.9	8.9	4.6
	Youngstown	6	2.2	5.4	3.5
Oklahoma:	Cherokee Co.*	6	0.4	8.3	3.2
	Oklahoma City	6	0.7	4.7	2.5
	Tulsa	7	0.8	4.3	2.8
Oregon:	Curry Co.*	3	0.3	0.9	0.5
	Portland	5	0.8	3.0	2.0
Pennsylvania:	Clarion Co.*	5	1.2	4.2	2.8
	Harrisburg	4	2.0	5.6	3.3
	Lancaster	7	4.5	11.9	6.6
	Philadelphia	6	1.2	8.0	4.7
	Pittsburgh	6	1.7	7.8	4.5
	Reading	5	0.5	5.3	3.2
	Wilkes Barre	6	2.6	6.6	3.9
Puerto Rico:	Loquillo Mtns.*	5	1.2	3.3	2.1
	San Juan	5	0.6	3.8	2.2
Rhode Island:	Providence	6	0.7	5.1	3.5
	Washington Co.*	7	0.9	4.1	2.7
South Carolina:	Columbia	6	1.7	6.6	4.4
	Greenville	6	1.2	10.3	4.3
	Richland Co.*	6	1.0	8.4	4.0
South Dakota:	Black Hills Forest*	6	2.1	3.2	4.4
	Sioux Falls	4	2.8	7.5	4.1

* Nonurban station.

TABLE 2.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, NASN, THIRD QUARTER, 1962—Con.

[Concentrations in pc/m³]

Station location		No. of Samples	Minimum	Maximum	Average
Tennessee:	Chattanooga	7	0.9	6.8	3.1
	Memphis	6	0.7	6.9	3.8
	Nashville	7	0 7	6.3	3.8
Texas:	Arkansas Co.*	5	0.7	3.5	2.3
	Corpus Christi	7	0.8	4.0	2.3
	Dallas	5	0.7	5.6	3.0
	El Paso	6	1.6	5.7	2.9
	Ft. Worth	5	0.7	3.1	2.0
	Houston	6	0.7	3.3	2.4
	San Antonio	5	1.1	2.9	2.0
	Waco	6	0.6	6.0	2.9
Utah:	Salt Lake City	7	2.6	9.8	5.9
Vermont:	Burlington	4	4.7	5.9	5.4
	Orange Co.*	7	1.9	7.3	3.8
Virginia:	Danville	6	2.1	14.3	5.7
	Norfolk	7	0.4	5.8	4.3
	Shenandoah Natl. Pk.*	6	3.4	8.2	5.1
Washington:	Clallam Co.*	3	0.2	1.3	0.9
	Seattle	7	0.5	2.7	1.2
	Tacoma	6	1.0	3.0	1.8
West Virginia:	Charleston	6	0.4	7.8	3.9
	Huntington	6	2.0	8.6	3.9
Wisconsin:	Door Co.*	5	0.6	5.5	3.1
	Milwaukee	5	1.4	4.7	2.4
	Racine	6	2.0	3.8	2.8
Wyoming:	Cheyenne	6	1.8	4.6	1.3
	Yellowstone Pk.*	4	4.4	10.5	6.7

* Nonurban station.

TABLE 3.—FISSION PRODUCT GROSS BETA ACTIVITY IN PRECIPITATION, NASN, THIRD QUARTER, 1962

Station		July		August		September	
		pc/liter	nc/m²	pc/liter	nc/m²	pc/liter	nc/m²
Alabama:	Montgomery	587	56.1	549	48.9	109	9.3
Florida:	Tampa	487	20.7	137	24.4	106	11.8
Illinois:	Chicago, (Midway)	686	76.9	—	—	—	—
	Chicago, (O'Hare)	743	91.8	—	—	—	—
Louisiana:	Lake Charles	—	—	99	35.6	—	—
Maine:	Caribou	523	88.9	558	36.6	1,133	99.7
Massachusetts:	Nantucket	780	65.5	253	20.0	355	28.8
Michigan:	Sault Ste. Marie	—	—	474	49.8	448	35.8
Minnesota:	St. Cloud	623	79.7	536	40.7	557	37.1
Missouri:	Columbia	966	66.7	—	—	436	65.8
Montana:	Glasgow	510	46.7	—	—	—	—
Nebraska:	Grand Island	663	125.3	—	—	—	—
New York:	Albany	494	22.2	811	48.3	424	36.8
North Carolina:	Cape Hatteras	550	42.4	170	40.8	166	27.7
Ohio:	Cincinnati (Airport)	521	105.6	477	17.3	232	13.5
	Cincinnati (Gest St.)	522	50.9	—	—	—	—
Pennsylvania:	Philadelphia	220	11.4	277	44.0	432	16.5
South Carolina:	Charleston	2,487	358.1	79	23.4	341	25.6
	Greenville	674	55.9	354	36.1	426	24.0
Tennessee:	Nashville	—	—	387	21.7	216	38.9
Texas:	Amarillo	344	42.3	357	15.0	404	21.4
	San Angelo	407	17.9	—	—	224	12.6
Washington:	Tatoosh	—	—	236	27.1	332	17.6

of Radiological Health, Public Health Service, in testimony before the Joint Committee on Atomic Energy in May 1959.* Subsequent data have been published quarterly in *Radiological Health Data* beginning with the October 1960 issue. Third quarter 1962 data are presented in table 2.

Gross Beta Activity in Precipitation

During 1959 a precipitation collection and analysis program was established by the Weather Bureau Research Station in Cincinnati, Ohio, and the National Air Sampling Network. The collection stations are located at Weather Bureau offices or airport stations. Monthly composite samples of precipitation are collected at 29 stations and forwarded to the Network laboratory for analysis.

Samples are analyzed for total solids and a large number of metals and nonmetals. In addition, each sample is analyzed for fission product gross beta radioactivity if sufficient volume remains after chemical analyses have been made. Third quarter 1962 data are presented in table 3.

* U.S. Atomic Energy Commission: "Hearings, Fallout from Nuclear Weapons Tests," *1*:173–85 (May 1959).

CANADIAN RADIOACTIVE FALLOUT STUDY PROGRAM
Second and Third Quarters 1962

Department of National Health and Welfare, Ottawa, Canada

As part of its Radioactive Fallout Study Program (RFSP), the Radiation Protection Division, Department of National Health and Welfare, Dominion of Canada, conducts air and precipitation sampling programs. The 24 air and precipitation stations are located at airports, and the equipment is operated by meteorologists of the Meteorological Services Branch of the Department of Transport.

About 653 cubic meters of air are drawn through a high-efficiency 4–inch diameter filter during a 24–hour period. Filters are sent daily to the Radiation Protection Division Laboratory in Ottawa. A 2–inch diameter disk is removed from each filter and counted with a thin end-window Geiger flow counter system, calibrated with a Sr^{90}–Y^{90} standard. Four successive measurements are made on each filter to allow for the presence of natural activities and for the decay of short-lived fission products. The result is extrapolated to the end of the sampling period. Air data for second and third quarters 1962 are presented in table 4.

The amount of radioactive fallout being deposited on the ground is determined from measurements on material collected in special polythene-lined rainfall pots. After transfer of the water to the sampling container, the polythene liner is removed, packed with the sample, and sent to the laboratory. Second and third quarter precipitation data are presented in table 5.

More detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in the Department's annual reports for 1959 and 1960 (*1*, *2*).

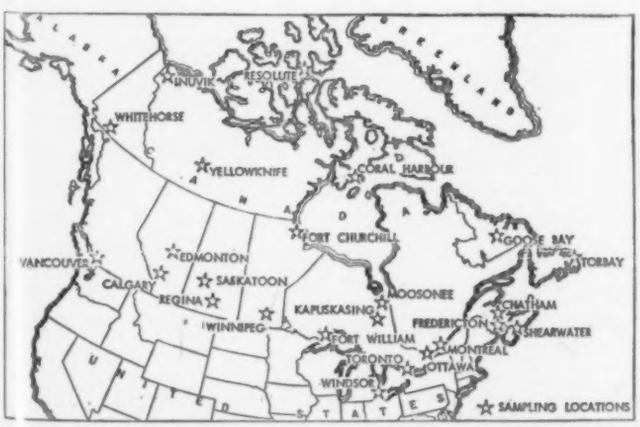

FIGURE 4.—CANADIAN AIR AND PRECIPITATION SAMPLING STATIONS

REFERENCES

(*1*) Bird, P. M., A. H. Booth, and P. G. Mar: *Annual Report for 1959 on the Radioactive Fallout Study Program, CNHW (RP–3)*, (May 1960).
(*2*) Bird, P. M., A. H. Booth, and P. G. Mar: *Annual Report for 1960 on the Radioactive Fallout Study Program, CNHW (RP–4)*, (December 1961).

Recent coverage in *Radiological Health Data:*

Period	Issue
First quarter 1961	*December 1961*
Second quarter 1961	*February 1962*
Third quarter 1961	*May 1962*
Fourth quarter 1961	*September 1962*
First quarter 1962	*October 1962*

TABLE 4.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, RFSP, SECOND AND THIRD QUARTERS 1962

[Average concentrations in $\mu\mu c/m^3$]

Station location	April	May	June	July	August	September
Calgary	8.0	5.1	7.5	4.7	4.1	13.1
Chatham	5.7	4.8	6.0	3.3	2.3	5.7
Coral Harbor	6.1	4.4	3.2	3.9	1.2	5.1
Edmonton	5.1	4.8	5.0	3.4	2.6	7.8
Ft. Churchill	5.5	4.3	*NS	1.7	1.8	5.7
Ft. William	6.7	7.0	7.1	4.6	2.6	6.7
Fredericton	6.4	5.8	6.5	3.1	2.0	5.6
Goose Bay	6.1	3.9	5.2	2.3	1.9	4.2
Inuvik	6.8	3.8	3.4	3.1	2.7	3.0
Kapuskasing	7.5	6.1	7.3	4.6	2.7	6.1
Montreal	6.7	6.6	7.9	4.6	3.4	9.3
Moosonee	7.8	5.8	5.5	4.0	2.0	4.2
Ottawa	6.9	6.5	8.5	5.0	3.4	6.3
Regina	7.5	6.0	7.3	4.8	3.1	12.7
Resolute	7.3	4.5	1.7	2.1	1.4	2.3
Saskatoon	6.2	6.4	7.2	4.1	4.3	9.7
Shearwater	7.3	4.2	6.4	3.3	2.4	4.2
Torbay	5.2	3.2	3.1	2.5	3.1	5.9
Toronto	7.4	6.8	7.7	5.3	3.3	8.7
Vancouver	5.7	4.0	3.9	2.6	1.9	11.0
Whitehorse	4.6	4.5	4.0	3.2	2.7	5.0
Windsor	9.1	7.9	7.6	6.0	3.7	9.1
Winnipeg	6.1	6.0	5.9	4.7	3.1	6.1
Yellowknife	7.0	5.1	5.3	4.2	3.5	9.8
Overall average	6.6	5.3	5.8	3.8	2.7	7.0

*NS denotes no sample.

TABLE 5.—FISSION PRODUCT GROSS BETA ACTIVITY IN PRECIPITATION, RFSP, SECOND AND THIRD QUARTERS 1962

Station location	April		May		June		July		August		September	
	Concentration (μμc/liter)	Deposition (mμc/m²)	Concentration (μμc/liter)	Deposition (mμc/m²)	Concentration (μμc/liter)	Deposition (mμc/m²)	Concentration (μμc/liter)	Deposition (mμc/m²)	Concentration (μμc/liter)	Deposition (mμc/m²)	Concentration (μμc/liter)	Deposition (mμc/m²)
Calgary	1,481	22.2	579	32.9	4,002	180.9	565	18.8	3,533	195.5	37.6	1,397
Chatham	518	60.5	2,915	122.2	1,788	99.4	857	154.2	444	51.9	112.1	1,014
Coral Harbor	2,368	19.8	3,405	45.8	9,328	45.0	1,360	54.2	968	70.8	71.9	1,555
Edmonton	2,990	107.0	2,552	145.8	2,447	190.8	1,549	124.6	2,163	124.1	75.9	2,929
Fredericton	865	83.0	3,767	110.0	2,052	103.7	410	48.4	698	67.3	113.0	1,196
Ft. Churchill	1,516	50.0	1,981	49.3	1,918	166.1	1,388	64.2	792	89.1	75.7	1,923
Ft. William	2,219	122.9	3,297	202.6	3,815	138.6	1,198	104.3	866	107.1	135.3	1,595
Goose Bay	553	34.1	1,482	94.5	1,414	101.9	911	84.6	1,185	63.0	66.9	1,014
Inuvik	547	11.5	3,233	27.1	1,318	59.6	1,409	99.5	1,462	74.7	57.9	2,716
Kapusaking	1,117	43.7	667	115.3	868	44.5	711	85.7	248	39.5	68.6	535
Montreal	1,698	212.2	2,791	109.1	1,099	85.3	866	110.4	979	58.6	96.6	1,398
Moosonee	1,186	34.9	2,811	219.1	980	55.3	942	124.2	1,029	88.1	150.2	1,032
Ottawa	1,721	138.5	2,168	83.1	2,032	148.6	1,204	155.6	1,231	69.1	175.8	2,499
Regina	3,800	83.0	2,120	90.4	3,177	308.1	1,763	90.0	2,380	139.7	46.9	5,281
Resolute	* tp	39.2	4,490	14.8	2,026	12.4	939	16.9	766	8.8	47.0	3,560
Saskatoon	9,439	50.3	1,496	35.3	1,674	164.4	2,110	70.2	2,104	94.6	115.4	4,835
Shearwater	1,161	172.5	2,196	110.5	1,450	133.7	836	113.4	587	73.0	133.6	766
Torbay	1,629	98.9	1,705	73.6	952	92.1	921	130.3	552	30.1	82.3	508
Toronto	2,478	78.6	3,461	97.6	2,534	166.6	1,395	128.2	1,330	52.4	115.1	724
Vancouver	1,560	141.4	1,224	53.2	2,877	60.6	1,003	25.5	1,496	134.5	116.0	1,806
Whitehorse	1,295	17.8	2,472	31.4	2,005	123.8	2,803	51.3	1,173	53.1	53.0	1,899
Windsor	1,938	186.0	2,434	80.3	1,566	198.9	1,506	118.2	759	73.2	133.5	1,695
Winnipeg	2,032	34.6	1,902	259.7	2,155	115.5	1,114	173.0	842	146.1	48.8	3,096
Yellowknife	8,892	13.5	10,894	41.5	2,034	58.4	2,522	78.7	1,386	69.0	49.3	13,864
Average	2,304	77.3	2,745	93.5	2,313	118.9	1,262	92.7	1,207	82.2	90.8	2,452

* tp denotes trace precipitation.

Strontium–90 Deposition on the Earth's Surface*
1958–1961

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Quarterly strontium–90 deposition figures based on the worldwide pot and resin column collections made by the Health and Safety Laboratory (HASL) during 1958, 1959, and 1960, have been reported previously (*1*). Similar data are presented below. The results of strontium–89 determinations, performed on the samples collected during the last four months of that year, are also included.

Until the last half of 1960, the monthly samples were analyzed individually. In anticipation of diminishing fallout rates, the monthly collections were combined on a two-month basis through August 1961. Thereafter, analyses of individual monthly collections were resumed.

Samples collected in 1958 and 1959 were analyzed for strontium–89 and strontium–90. Tungsten–185, produced in the 1958 Hardtack tests, was detectable in fallout during the latter half of 1958 and throughout 1959. Deposition studies at HASL involving these three radionuclides (*2*, *3*, *4*) were aimed at estimating relative contributions of different sources to total fallout radioactivity. Only strontium–90 was determined in the collections made in 1960, since the activity levels of the shorter-lived nuclides were not detectable.

Average bimonthly (from January through August) and monthly (from September through December) strontium–90 deposition figures in millicuries per square mile for 1961 for each ten degrees of latitude from 50° north to 50° south, are presented in table 1. Data for stations located between 50° and 80° north latitude were combined. The bimonthly and monthly values were summed to give a yearly value for each latitude band. These data are plotted in figure 1 and show the expected lati-

* U.S. Atomic Energy Commission: *Fallout Program Quarterly Summary Report, HASL–131*:221–9, Office of Technical Services, Department of Commerce, Washington 25, D.C. (October 1, 1962), price $3.50.

TABLE 1.—1961 AVERAGE STRONTIUM-90 FALLOUT BY BANDS OF LATITUDE

[Millicuries Sr^{90} per square mile]

Period	80–50°N	50–40°N	40–30°N	30–20°N	20–10°N	10°N–0	0–10°S	10–20°S	20–30°S	30–40°S	40–50°S
January–February	0.33	0.52	0.53	0.64	0.21	0.23	0.12	0.14	0.33	0.36	0.28
March–April	0.50	1.01	0.78	0.54	0.27	0.35	0.22	0.16	0.30	0.36	0.28
May–June	0.55	0.99	0.74	0.63	0.27	0.41	0.28	0.08	0.15	0.33	0.48
July–August	0.45	0.40	0.33	0.27	0.18	0.19	0.09	0.19	0.17	0.45	0.21
September	0.28	0.21	0.13	0.12	0.14	0.09	0.12	0.10	0.21	0.14	0.13
October	0.38	0.43	0.18	0.28	0.13	0.08	0.03	0.33	0.33	0.27	0.22
November	0.49	0.70	0.66	0.38	0.24	0.20	0.29	0.25	0.36	0.33	0.08
December	0.59	0.95	0.91	0.69	0.23	0.40	0.34	0.12	0.40	0.25	0.18
Total during 1961	3.57	5.21	4.26	3.55	1.67	1.95	1.49	1.37	2.25	2.49	1.86

tudinal deposition profile (*5*). A maximum at 40°–50° north, a minimum in the equatorial regions, and a slight rise from 20°–40° in the southern hemisphere can be noted.

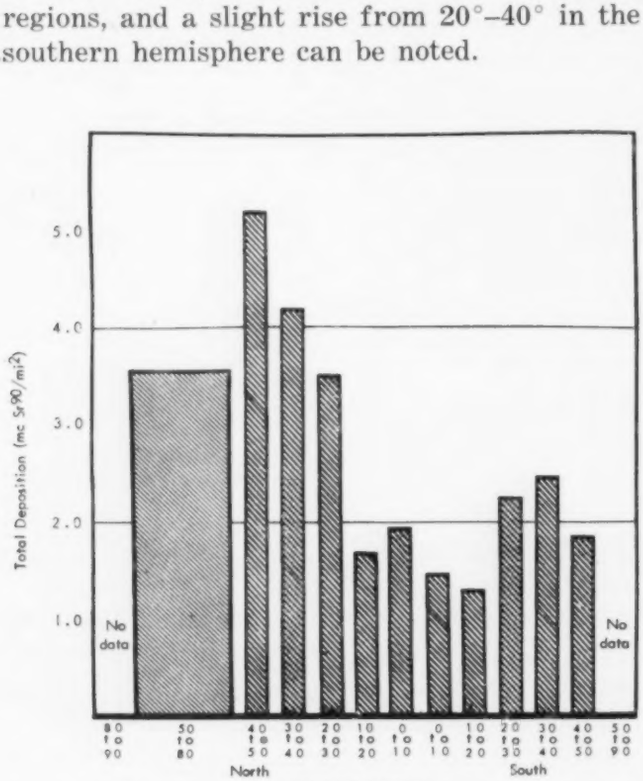

FIGURE 1.—TOTAL STRONTIUM-90 DEPOSITION DURING 1961, BY LATITUDE BAND

It is important to note that the sampling sites, from a climatic standpoint, were assumed to be representative of the latitude band in which they are located. The values were not corrected for differences in precipitation since rainfall information is lacking in a considerable number of cases. Kosta Telegadas of the U.S. Weather Bureau has used two methods to average the data in order to compute the total global ground fallout (*6*, *7*, *8*, *9*). The first method involves the determination of the arithmetic average deposition for each 10 degrees of latitude and the drawing of a smooth curve through the points. This method assumes (as in this presentation) that the arithmetic average of the selected sites is representative of the average value for the whole latitude band. The second method attempts to compensate for the climatic differences by using the average rainfall in a latitude band. The smoothed latitudinal curves of deposition for the two methods are integrated to give the global fallout in megacuries of strontium–90. In this report, the arithmetic average fallout rate for each latitude band has been multiplied directly by the area of the band to give the total activity of strontium–90 deposited. These values for 1961, reported in megacuries, are given in table 2.

In table 3, estimates are given of the total strontium–90 deposition in the northern and southern hemispheres by quarters since 1958. These figures include only the land areas of the earth covered by the pot and resin column collectors, i.e. 80° north to 50° south, and no attempt was made to extrapolate the available data to include those latitudes not covered by

TABLE 2.—1961 ARITHMETIC AVERAGE STRONTIUM-90 FALLOUT, BY BANDS OF LATITUDE

[Megacuries]

Latitude band	80–50°N	50–40°N	40–30°N	30–20°N	20–10°N	10°N–0	0–10°S	10–20°S	20–30°S	30–40°S	40–50°S
Total deposition	0.077	0.064	0.060	0.055	0.028	0.033	0.025	0.023	0.035	0.035	0.023
Number of sites	12	25	19	14	10	13	9	7	8	7	2

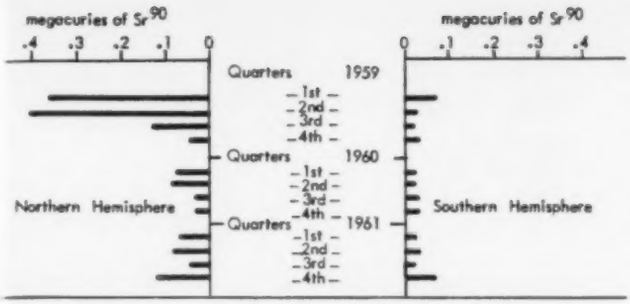

FIGURE 2.—QUARTERLY DEPOSITION OF STRONTIUM-90, 1959–1961

the sampling network. In 1958, the number of sampling stations was too sparse to treat the northern and southern hemispheres separately.

The quarterly strontium-90 deposition, including time of deposition from 1958 through 1961 is plotted in figure 2 for the northern and southern hemispheres. The heaviest fallout occurred during the first six months of 1959 in the northern hemisphere and was followed by a sharp decline during the latter half of the year. During the last quarter of 1959, the deposition in the northern hemisphere was very nearly the same as that which had been characteristic of the southern hemisphere since April. The seasonal rise in the northern hemisphere was very much in evidence during 1960 and 1961. One interesting point is that the spring increase in 1961 was only slightly less than that observed in 1960. The deposition rate in the southern hemisphere appears to have remained rather constant through 1960 and the first nine months of 1961. The increase in the northern hemisphere during the last quarter of 1961 is attributed to the resumption of weapons testing in September, but the apparent increase in the southern hemisphere probably involves an influx of old debris as well as a contribution from the 1961 testing.

TABLE 3.—ESTIMATES OF TOTAL STRONTIUM-90 DEPOSITION BY HEMISPHERE AND QUARTER

[Megacuries]

Period	Northern Hemisphere	Southern Hemisphere	Northern and Southern Hemispheres
1958			
First quarter			0.14
Second quarter			0.24
Third quarter			0.18
Fourth quarter			0.21
Total			0.77
1959			
First quarter	0.36	0.066	0.43
Second quarter	0.41	0.025	0.43
Third quarter	0.12	0.025	0.14
Fourth quarter	0.04	0.033	0.08
Total	0.93	0.149	1.08
1960			
First quarter	0.079	0.027	0.106
Second quarter	0.086	0.022	0.108
Third quarter	0.036	0.022	0.058
Fourth quarter	0.029	0.035	0.064
Total	0.230	0.106	0.336
1961			
First quarter	0.064	0.028	0.092
Second quarter	0.082	0.030	0.112
Third quarter	0.045	0.027	0.072
Fourth quarter	0.124	0.062	0.186
Total	0.315	0.147	0.462

TABLE 4.—RATIOS OF STRONTIUM–89 TO STRONTIUM–90 IN FALLOUT AT MIDPOINTS OF LATITUDE COLLECTION BANDS—1961

Period	80–50°N	50–40°N	40–30°N	30–20°N	20–10°N	10°N–0	0–10°S	10–20°S	20–30°S	30–40°S	40–50°S
September	45	53	25	31	10	19	10	<1	<1	<1	<1
October	59	74	70	54	71	15	5	<1	<1	<1	<1
November	69	77	78	69	65	81	44	<1	<1	<1	<1
December	49	56	59	60	58	61	58	<1	<1	<1	<1

Analyses for strontium–89 were carried out on samples collected during the last four months of 1961 and the monthly average Sr^{89}/Sr^{90} ratios for the latitude bands under consideration are given in table 4. Since strontium–89 was not detected in any samples collected below 10° south latitude, it can be concluded that no pronounced effects from the 1961 fall testing occurred below this latitude. A steady increase in strontium–90 deposition was observed (see table 1) from October through December at sites north of 10° south latitude whereas the deposition rate for sites below this latitude either fluctuated or remained steady. It is quite evident that massive trans-equatorial movement of polar debris had not occurred during the fall of 1961.

From the strontium–89 deposition, it is possible to estimate the contribution to the total strontium–90 deposition rates after the 1961 tests. October 18, 1961 was assumed to be representative of the date of origin of debris deposited in the northern hemisphere during November and December 1961. Using a theoretical Sr^{89}/Sr^{90} ratio at production of 146 (*10*), it was calculated that between 70 and 75 percent of the northern hemisphere strontium–90 fallout in November originated from the U.S.S.R. tests. In December 1961, the U.S.S.R. contribution was about 85 per cent.

The present estimate reveals that about 0.46 megacuries of strontium–90 were deposited in 1961 within those latitude bands covered by the sampling network compared to 0.34 megacuries deposited in 1960 (table 3). The northern hemisphere received about twice as much fallout in 1960 and 1961 as the southern hemisphere. This difference is expected to be substantially larger in 1962.

Had nuclear testing not been resumed in the fall of 1961, the total strontium–90 deposition in the northern hemisphere for that year would probably have been about the same as it was in 1960. Furthermore, the trend towards equalization of annual fallout rates between the northern and southern hemispheres would most likely have continued.

REFERENCES

(*1*) Frankel, R., and E. Hardy: Strontium–90 on the Earth's Surface During 1958, 1959, and 1960, *Fallout Program Quarterly Summary Report, HASL–113*: 107–15, Office of Technical Services, Department of Commerce, Washington 25, D.C. (July 1, 1961), price $2.50.

(*2*) Harley, J. H.: Quarterly Summary of Monthly Fallout Deposition Data, *Fallout Program Quarterly Summary Report, HASL–84*:140–3, Office of Technical Services, Department of Commerce, Washington 25, D.C. (April 1, 1960), price $3.00.

(*3*) Harley, J. H.: Quarterly Summary of Monthly Fallout Deposition Data, *Fallout Program Quarterly Summary Report, HASL–88*:190–4, Office of Technical Services, Washington 25, D.C. (July 1, 1960), price $3.50.

(*4*) Hardy, E.: Tungsten–185 Deposition on the Earth's Surface, *Fallout Program Quarterly Summary Report, HASL–95*:203–7, Office of Technical Services, Department of Commerce. Washington 25, D.C. (October 1, 1960), price $3.00.

(*5*) Alexander, L. T., R. H. Jordan, R. F. Dever, E. Hardy, G. Hammada, L. Machta, and R. List: *Strontium–90 on the Earth's Surface—Summary and Interpretation of a World-Wide Soil Sampling Program*, U.S. Atomic Energy Commission *TID–6567*, Office of Technical Services, Department of Commerce, Washington 25, D.C. (February 1961), price $0.75.

(*6*) Telegadas, K.: Global Integrals of Strontium–90 by the Pot Method, *Fallout Program Quarterly Summary Report, HASL–84*:144–67, Office of Technical Services, Department of Commerce, Washington 25, D.C. (April 1, 1960), price $3.00.

(*7*) Telegadas, K.: Global Integrals of Monthly Strontium–90 Fallout, June–November 1959, *Fallout Program Quarterly Summary Report, HASL–95*:164–73, Office of Technical Services, Department of Commerce, Washington 25, D.C. (October 1, 1960), price $3.00.

(*8*) Telegadas, K.: Global Integrals of Monthly Strontium–90 Fallout, December 1959–May 1960, *Fallout Program Quarterly Summary Report, HASL–111*: 159–68, Office of Technical Services, Department of Commerce, Washington 25, D.C. (April 1, 1961), price $3.00.

(*9*) Telegadas, K.: Global Integrals of Monthly Strontium–90 Fallout, January 1958–December 1960, *Fallout Program Quarterly Summary Report, HASL–115*:253–6, Office of Technical Services, Department of Commerce, Washington 25, D.C. (October 1, 1961), price $5.00.

(*10*) Hallden, N. A., I. M. Fisenne, L. D. Y. Ong, and J. H. Harley: Radioactive Decay of Weapons Debris, *Fallout Program Quarterly Summary Report, HASL–117*:194–9, Office of Technical Services, Department of Commerce, Washington 25, D.C. (December 30, 1961), price $3.50.

SECTION II.—FOOD

Tri-City Diet Study*

April 1962

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Since May 1960 the Health and Safety Laboratory, through its quarterly diet study, has made estimates of the strontium–90 content of the average diet of individuals living in New York City, San Francisco, and Chicago.

Selected foods, representing 19 food categories, are purchased at each of these 3 cities about every 3 months and are analyzed for strontium–90. Using data from the U.S. Department of Agriculture "Household Food Survey of 1955," the annual consumption by an average individual can be grouped into the same 19 food categories. The annual dietary intake of strontium–90 can then be estimated by summing the contributions from each category. Some food types are assumed to be representative of larger food categories, such as liquid milk for dairy products in general.

The consumption data from the "Household Food Survey of 1955" are based on a weight-as-purchased basis. Before the food samples for the Tri-City Diet Study are ashed for radiochemical analysis, they are prepared to a certain degree, as if for actual consumption. For example, fruits are peeled, eggs are shelled, and poultry is de-boned. Therefore, concentrations of radioactivity in foods as reported in the Tri-City Diet Study are based on analyses of the trimmed portions of foods.

Results obtained from the eighth sampling of foods (April 1962) are presented in table 1. The variation with time of the daily intake of strontium–90 in the 3 cities is plotted in figure 1.

Because of the resumption of atmospheric tests of nuclear weapons by the U.S.S.R. in the fall of 1961, it was possible to ascertain what foods were most quickly contaminated with fresh fallout by analyzing the foods for the relatively short-lived fission product strontium–89 (half-life = 51 days).

Significant levels of strontium–89 were found in milk, fresh vegetables, and potatoes. From the observed Sr^{89}/Sr^{90} ratios in the foods, and from an estimate of the Sr^{89}/Sr^{90} ratio for fallout coming exclusively from the U.S.S.R. test series, it was possible to make a crude estimate of the fraction of strontium–90 from this test series found in the food.

These estimates indicate that about 80 percent of the strontium–90 detected in milk in San Francisco probably came from the U.S.S.R. tests. About 60 percent of the strontium–90 in milk from New York City and about 10 percent of the strontium–90 in milk from Chicago was due to fresh fallout.

The previously noted geographic pattern of distribution of strontium–90 in foods is seen to persist in the last sampling. New York City has the highest levels, while Chicago has intermediate levels. Milk continues to be the predominant source of strontium–90 in the diet. This is partly due to its high annual consumption.

* U.S. Atomic Energy Commission: *Fallout Program Quarterly Summary Report, HASL–131*:235–8, Office of Technical Services, Department of Commerce, Washington 25, D.C. (October 1, 1962), price $3.50.

TABLE 1.—AVERAGE PERSON DIETARY CONSUMPTION AND STRONTIUM-90 INTAKE—EIGHTH SAMPLING

Food Category	Average U. S. Consumption		New York City April 1962		Chicago April 1962		San Francisco April 1962	
	Food (kg/yr)	Calcium (g/yr)	(μμc/kg)	(μμc/yr)	(μμc/kg)	(μμc/yr)	(μμc/kg)	(μμc/yr)
Bakery products	37	37.0	2.8	104	6.5	241	5.1	18
Whole grain products	11	10.0	7.7	85	10.4	114	6.2	6
Eggs	16	9.1	1.5	24	2.4	38	0.1	
Vegetables, fresh	43	15.0	5.5	237	9.1	389	1.3	5
Vegetables, root	17	6.1	4.4	75	5.8	98	2.7	4
Milk	221	234.3	9.3	2,044	4.8	1,056	5.2	1,15
Poultry	17	9.2	0.8	14	1.0	16	0.8	1
Fish, fresh	8	10.8	0.4	3	0.7	6	0.9	
Flour	43	8.6	4.5	194	4.8	207	2.1	9
Macaroni	3	0.7	3.2	10	4.1	12	3.2	1
Rice	3	1.1	2.3	7	1.8	5	1.5	
Meat	73	10.9	1.6	117	1.4	105		[a] 3
Fish, shell	1	0.8	8.2	8	1.3	1	0.7	0
Beans, dried	3	2.9	10.3	31	10.8	32	2.4	7
Fruit, fresh	68	13.6	8.8	598	7.6	515	1.5	9
Potatoes	45	5.8	3.8	171	2.1	131	1.6	72
Fruit, canned	26	1.3	1.2	31	1.2	30	0.5	13
Juices, fruit	19	1.7	3.8	72	1.9	37	2.7	51
Vegetables, canned	20	4.2	3.7	74	5.3	106	1.3	25
Annual intake	674	383	5.8	3,899	4.7	3,139	2.9	1,940
Strontium-90 to calcium ratio in total diet			10.2 (μμc Sr^{90}/g Ca)		8.2 (μμc Sr^{90}/g Ca)		5.1 (μμc Sr^{90}/g Ca)	

[a] Estimated from seventh sampling.

Not only is the total intake of strontium–90 of interest but also the strontium–90 to calcium ratio, Sr^{90}/g Ca, expressed as μμc strontium–90 per gram calcium. [*Editor's note: The Sr^{90}/g Ca ratio may be thought of as the amount of strontium–90 existing in a material per unit of calcium existing in the same material. From a given foodstuff, a certain amount of calcium is retained in the body, and the amount of strontium–90 which coexists with the calcium in this foodstuff is a determining factor in how much strontium–90 is deposited.*] These ratios for the total diet are shown in table 1.

The Sr^{90}/g Ca ratios in milk have been used to estimate the Sr^{90}/g Ca ratios in the total diet. The validity of this use of the Sr^{90}/g Ca ratio in milk as an indicator for the Sr^{90}/g Ca in the total diet may depend on the nature and rate of fallout. The ratio of the Sr^{90}/g Ca ratio in the total diet to the Sr^{90}/g Ca ratio in the milk was 1.1, 1.7, and 1.0 for New York, Chicago, and San Francisco, respectively, in April. Values obtained previously have ranged from 1.0 to 2.0. There seems to be a tendency, as exemplified in the last sampling, for the ratio to be lower during periods of higher fallout rates than during periods of lower fallout rates. Expressed differently, during periods with greater fallout rates, a greater percentage increase of the Sr^{90}/g Ca ratio occurs in milk than in other foods. If this is true, then a reasonable estimate of total diet Sr^{90}/g Ca ratio made by multiplying the milk Sr^{90}/g Ca ratio by a factor of 1.5 would be on the conservative side during periods of heavy fallout, since the use of this factor would overestimate the Sr^{90}/g Ca ratio in the total diet.

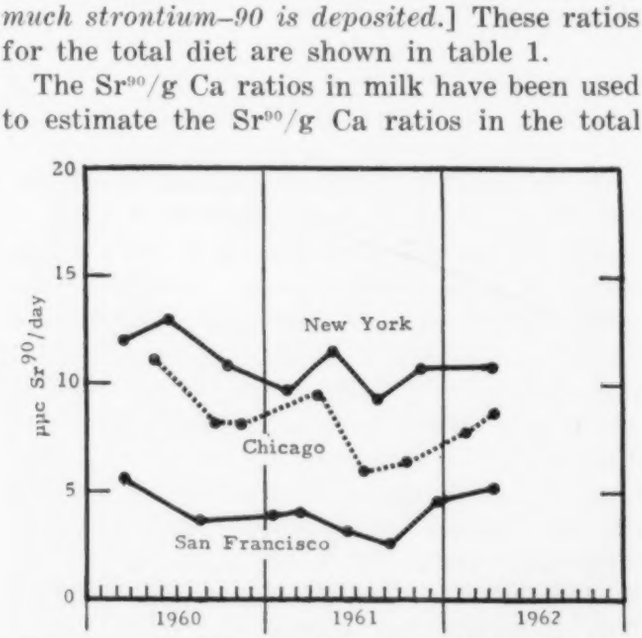


FIGURE 1.—DAILY INTAKE OF STRONTIUM–90 IN TRI-CITY TOTAL DIETS

Previous coverage in *Radiological Health Data:*

Period	Issue
Third sampling (October 1960–January 1961)	*October 1961*
Fourth sampling (February–April 1961)	*December 1961*
Fifth sampling (May–July 1961)	*March 1962*
Sixth sampling (August–October 1961)	*June 1962*
Seventh sampling (November 1961–February 1962)	*September 1962*

Editor's note: A necessary step in determining the dietary intake of radioactivity is the securing of information on kinds and amounts of food consumed by the population of the United States. Because of the importance of whole milk, particularly in the diet of infants and children, recently obtained milk consumption data from a national survey are published below.

National Food Consumption Survey

FRESH WHOLE MILK CONSUMPTION IN THE UNITED STATES
July 1962

Bureau of the Census, Department of Commerce and Division of Radiological Health, Public Health Service

The data below on whole milk consumption in July 1962 are the first available from the National Food Consumption Survey being conducted by the Bureau of the Census on behalf of the Public Health Service. Additional material showing the mean food consumption values and associated errors is now being prepared for milk and for four other selected food items (beef, white sliced bread, lettuce, and apples). These data were obtained in the July test of this survey. During the first two weeks of each quarter, beginning July 1962, a representative sample of the U.S. population is being surveyed to provide estimates of the amounts and kinds of food consumed. The survey is being conducted with the support of the Division of Radiological Health (DRH), and the Heart Disease Control Program (HDCP), Division of Chronic Diseases of the PHS.

The survey was designed initially to develop the methods and procedures for the collection of data related to individual consumption of selected food items. In subsequent months similar information will be gathered by the survey procedure on additional selected food items and components of the total diet.

Consumption estimates from this survey will be related to personal characteristics such as age and sex, region of residence, and socioeconomic characteristics. This survey is now a component of the Census Bureau's Quarterly Household Survey.

Use in Dietary Intake Estimates

Plans are to combine food consumption estimates obtained from the survey with radiation concentration data collected in the Division of Radiological Health's National Dietary Assessment Program to produce estimates of radionuclide intake from the diet. It is intended that these data will provide an empirical basis for establishing or revising radiation exposure guides and standards for this source. Also, the program is designed to determine the feasibility of using an "indicator food list" for the

surveillance and assessment of radionuclide intake.

Design of Survey

In July the Food Consumption Survey was conducted in 333 primary sampling units located in every State and the District of Columbia. This sample contained a total of approximately 11,500 housing units (both occupied and vacant) and completed interviews were obtained in approximately 8,900 of these, containing about 28,000 persons.

In the initial phase of the survey, two experimental techniques were used. First, in one systematic subsample, a three-day recall personal interview was used as a collection device. In another subsample, a one-day recall interview was conducted and the respondent was asked to maintain a diary for a three-day period. In about one-third of the latter group, the interviewer returned after the record period to pick up and review the diary; in the remaining two-thirds, the respondent was asked to mail the completed diary. This was done to measure differences in response rates and quality of response. Since all of these procedures utilized probability samples, the results may be compared directly. One limitation of the procedure was that it was not feasible (because of other commitments in the Census survey) to randomize the interviews by day of the week. To the extent that consumption patterns vary significantly by day of the week, additional errors may be introduced. The figures shown in table 1 are based only on the results of the personal interviews—both the three-day recall and the one-day recall; final results of the diary approach as yet are not available. Examination of preliminary data obtained by diary, however, indicates no substantial differences.

Survey Results

Table 1 shows the percentage distribution of the amounts of whole milk consumed at home on an average day for the civilian non-institutional population of the United States. These estimates by age and sex and consumption categories are limited to fresh whole milk consumed *at home* and are based on a survey conducted during the first two weeks of July 1962. The number of observations indicate the person-days associated with each age and sex grouping.

While the table is self-explanatory, some items appear worthy of note. On an average

TABLE 1.—DAILY PERCENTAGE* DISTRIBUTION OF "AT HOME" CONSUMPTION OF WHOLE MILK BY AGE AND SEX—JULY 1962

Ages	Number of observations	Amount of milk consumed (fluid ounces)											
		0	1–3	4–7	8–11	12–15	16–19	20–23	24–27	28–31	32–35	36–39	40 or more
MALE													
All ages	32,012	32.1	5.7	7.8	11.6	5.9	10.0	4.2	7.6	2.7	6.8	1.3	4.2
Under 1	713	38.0	0.1	1.9	1.4	2.7	4.1	4.2	10.7	5.3	20.4	1.3	9.9
1–4	3,073	15.9	1.6	5.1	8.9	10.4	14.2	7.6	14.5	4.7	11.0	1.9	4.3
5–9	3,744	20.5	1.3	5.3	10.2	8.3	12.9	7.1	15.1	4.7	8.6	1.8	4.2
10–14	3,577	25.0	1.4	4.6	8.6	6.8	10.3	6.7	11.3	5.2	10.2	1.7	8.1
15–19	2,592	28.9	2.6	4.9	8.8	5.7	9.3	4.1	9.1	3.0	10.0	3.0	10.5
20–24	1,678	35.1	4.1	6.7	14.7	4.4	10.8	3.4	4.6	2.3	6.9	1.5	5.3
25–29	1,614	39.1	7.5	7.6	11.0	5.8	10.5	1.7	6.2	2.2	4.5	0.6	3.2
30–34	1,976	37.5	9.8	9.1	14.4	5.7	8.0	3.2	4.6	1.1	4.5	0.4	1.7
35–44	4,233	39.1	10.4	9.4	13.4	4.6	8.5	2.8	4.0	1.2	4.0	0.8	1.7
45–54	3,567	42.0	9.5	11.0	13.7	4.4	7.1	1.9	2.8	1.1	3.4	0.5	2.5
55–64	2,584	40.9	8.4	11.2	13.2	4.1	9.5	2.5	2.8	1.1	3.1	0.8	2.4
65 and over	2,661	35.4	8.2	12.8	15.8	4.5	10.1	2.5	3.5	1.2	4.0	0.6	1.5
FEMALE													
All ages	33,568	37.9	6.8	9.9	13.1	6.3	9.0	3.4	5.6	1.6	4.1	0.6	1.6
Under 1	747	41.2	0.5	1.1	3.2	2.3	4.5	3.4	9.6	5.7	20.5	1.5	6.5
1–4	2,890	17.3	1.1	7.2	10.2	11.1	12.0	7.9	12.6	4.1	10.9	1.7	3.9
5–9	3,536	23.6	1.6	6.9	11.5	9.9	13.9	7.2	11.5	2.9	6.8	1.2	3.0
10–14	3,399	32.3	2.1	5.6	12.3	7.1	11.2	6.3	10.3	3.1	5.4	1.4	2.8
15–19	2,661	39.4	4.0	6.4	13.0	6.3	10.1	4.1	7.2	1.7	5.1	0.6	2.1
20–24	1,984	42.8	6.6	7.9	17.2	6.5	7.8	2.3	4.6	1.1	2.1	0.3	0.9
25–29	1,807	43.1	10.2	9.9	14.6	5.0	8.2	1.5	2.6	1.3	2.1	0.6	0.8
30–34	2,094	43.9	12.3	11.7	14.7	4.3	7.0	1.2	2.3	0.9	1.0	0.2	0.5
35–44	4,674	45.3	11.8	12.5	12.2	5.0	6.7	1.6	2.5	0.5	1.5	0.1	0.4
45–54	3,695	46.2	9.9	12.3	15.6	4.3	6.0	1.8	1.6	0.2	1.5	0.2	0.3
55–64	2,840	45.1	9.3	14.0	13.1	4.9	7.2	1.0	2.2	0.5	1.7	0.2	0.7
65 and over	3,241	39.6	8.2	15.2	15.1	5.2	9.5	1.5	2.4	0.0	2.4	0.2	0.6

* Percentages based on number of "person observations."

day during the period over one-third of the *total* population reported no fresh, whole, white milk consumption at home. At the other end of the scale 12.3 percent of the males and 6.3 percent of the females reported a daily consumption of one quart or more. In the age group *under one* these extremes are even more striking; namely, approximately 40 percent reported no milk consumption in this form while approximately 30 percent reported consumption of a quart or more. These observations on the under one year of age group may be explained by the fact that the survey did not include breast and formula milk consumption, which would be an important factor for infants.

Teen-Ager Diet Survey

May 1961–August 1962

Division of Pharmacology, Food and Drug Administration

It has been estimated that among all age groups the 19–year–old male consumes more food daily than any other segment of the United States population (*1*). Using this information, the Food and Drug Administration is surveying the foods consumed by this particular teenage group as a method for conservatively estimating the radionuclide intake of other population groups.

The Food and Drug Administration's Teenage Diet Survey was begun on a pilot basis in May 1961, in the Washington, D.C. area. Since then the program has been expanded to include four other cities: San Francisco, Minneapolis, St. Louis, and Atlanta.

By selecting the 19–year–old male, who consumes 3.76 kilograms (about 8 pounds) of food per day as compared with the "standard man" who averages 2.2 kilograms (about 5 pounds) per day, the radionuclide intake in the average total diet can be conservatively estimated. For the purposes of the sampling program, total diet is defined as all food and drink consumed daily by the 19–year–old male living in a moderate income family. The composition of the diet as well as the proportions of its constituents are based on the 1955 survey of the United States Department of Agriculture (*1*).

Procedures

To duplicate the diet of a 19–year–old male, a list of 82 different items of food and drink was prepared. The amounts of these items, covering a two-week consumption period, were purchased from national food chains.

Four food chains were sampled, but the variation of radionuclide concentration in a particular food was found to be statistically insignificant. Every effort was made to locate the source of the food items and arrange representation in the sample on as broad a geographical basis as possible.

The food was prepared by professional dietitians at the National Institutes of Health in a manner comparable to domestic preparation procedure. All edible parts of the total diet (including drinking water) were homogenized into a slurry, and aliquots were analyzed for strontium–90 and cesium–137.

In addition to analyses of the total diet, the major constituent categories of the diet were also analyzed in order to identify the radionuclide contribution of each. The 11 categories and the separate food items they contain are as follows:

Dairy:	Fresh and processed milk, ice cream, cheese, butter, margarine.
Grain:	Flour, pancake mix, corn flakes, wheat cereal, rice flakes, puffed rice, rice, oatmeal, corn meal, macaroni, wheat bread, saltines, cookies, crackers, rolls, pie crust, cake, pudding mix, shredded wheat, grits.
Leafy vegetables:	Cauliflower, spinach, broccoli, celery, lettuce, cabbage, asparagus, mustard.
Smooth vegetables:	Cucumbers, peas, green beans, corn, mushrooms, summer squash, rhubarb, lima beans, green peppers.
Root vegetables:	Carrots, onions, beets, rutabagas, turnips.
Potatoes:	White potatoes, potato chips.
Dried beans:	Canned beans with pork, peanut butter, dried beans with pork.
Fruits:	Tomatoes, catchup, oranges, orange juice, bananas, raisins, peaches, apples, strawberries, cherries, pears, vinegar, grapes, watermelon, apricots.
Meat, eggs:	Beef, pork chops, pork sausage, bacon, chicken, fish, luncheon meat, frankfurt, beef liver, eggs.
Sugar, fats, oils:	Salad dressing, mayonnaise, shortening, sugar, jelly, syrup, molasses, candy.
Beverages: (excluding drinking water)	Tea, coffee, cocoa, soft drinks.

Inedible portions contained in foods were analyzed for the Washington, D.C. area only.

The dietary values for strontium–90 shown in table 1 cannot be directly compared with those shown in tables 2 and 3. This is due to (1) differences in the compositing procedures (inclusion or exclusion of drinking water) and (2) analytical limitations.

TABLE 1.—DISTRICT OF COLUMBIA AND METROPOLITAN AREA TOTAL DIET SURVEY, 19-YEAR-OLD MALE: STRONTIUM-90 INTAKE FROM THE CONSTITUENTS OF THE DIET OVER 14-DAY PERIODS IN MONTHS SHOWN

Diet items	Weight of Food Consumed		Strontium-90 in Food Consumed		Concentration of Strontium-90
	kg	percent	pc	percent	pc/kg
May 1961					
Dairy	12.090	26.7	85	50.3	7.0
Grain	6.780	15.0	20	11.9	2.9
Vegetables, leafy	1.238	2.74	3.5	2.07	2.8
Vegetables, smooth	1.340	2.96	4.3	2.55	3.2
Vegetables, root	0.666	1.48	1.6	0.95	2.4
Potatoes	3.169	7.00	7.7	4.55	2.4
Beans, dried	0.822	1.81	9.5	5.62	12
Fruits	5.510	12.2	11	6.51	2.1
Meat, eggs	3.421	7.56	16	9.24	4.6
Sugar, fats, oils	1.206	2.67	7.3	4.32	6.1
Beverages	9.048	20.0	3.4	2.02	0.4
Total	45.290	100.1	169	100.0	3.7
August 1961					
Dairy	12.472	28.4	114	61.6	9.2
Grain	5.816	13.2	18	9.90	3.2
Vegetables, leafy	1.098	2.50	2.7	1.45	2.5
Vegetables, smooth	1.246	2.84	6.2	3.34	5.0
Vegetables, root	0.917	2.09	2.3	1.24	2.5
Potatoes	2.598	5.92	5.7	3.07	2.2
Beans, dried	0.822	1.87	9.0	4.84	11
Fruits	4.825	11.0	7.0	3.77	1.5
Meat, eggs	3.657	8.33	11	6.08	3.1
Sugar, fats, oils	1.419	3.23	3.5	1.88	2.5
Beverages	9.048	20.6	5.5	2.96	0.6
Total	43.918	100.0	185.0	100.1	4.2
November 1961					
Dairy	12.186	27.4	92	48.6	7.5
Grain	5.943	13.4	24	12.7	4.0
Vegetables, leafy	1.119	2.52	3.1	1.64	2.7
Vegetables, smooth	0.932	2.10	6.4	3.36	6.9
Vegetables, root	0.799	1.80	2.3	1.22	2.9
Potatoes	2.858	6.43	5.4	2.85	1.9
Beans, dried	0.822	1.85	9.7	5.13	12
Fruits	5.590	12.6	15	8.13	2.8
Meat, eggs	3.762	8.46	20	10.4	5.2
Sugar, fats, oils	1.504	3.38	1.5	0.74	1.0
Beverages	9.048	20.4	9.7	5.13	1.1
Total	44.653	100.3	189	99.9	4.2

TABLE 1.—DISTRICT OF COLUMBIA AND METROPOLITAN AREA TOTAL DIET SURVEY, 19-YEAR-OLD MALE STRONTIUM-90 INTAKE FROM THE CONSTITUENTS OF THE DIET OVER 14-DAY PERIODS IN MONTHS SHOWN—(Continued)

Diet items	Weight of Food Consumed		Strontium-90 in Food Consumed		Concentration of Strontium-90
	kg	percent	pc	percent	pc/kg
February 1962					
Dairy	12.035	27.5	148	55.4	12
Grain	5.940	13.6	37.5	14.1	6.3
Vegetables, leafy	1.368	3.12	3.4	1.27	2.5
Vegetables, smooth	1.717	3.92	7.8	2.91	4.5
Vegetables, root	0.523	1.19	1.1	0.41	2.1
Potatoes	2.805	6.41	4.0	1.49	1.4
Beans, dried	0.822	1.88	9.1	3.41	11
Fruits	4.601	10.5	9.2	3.45	2.0
Meat, eggs	3.494	7.98	17.5	6.54	5.0
Sugar, fats, oils	1.431	3.27	6.0	2.25	4.2
Beverages	9.048	20.7	23.6	8.85	2.6
Total	43.784	100.1	267	100.1	6.1
May 1962					
Dairy	12.200	27.5	215	62.7	18
Grain	6.078	13.7	60	17.5	9.9
Vegetables, leafy	1.160	2.61	7.4	2.16	6.5
Vegetables, smooth	1.342	3.04	4.6	1.34	3.4
Vegetables, root	0.598	1.35	4.3	1.25	7.2
Potatoes	2.612	5.88	5.9	1.72	2.3
Beans, dried	0.820	1.85	8.2	2.39	10
Fruits	5.362	12.1	11	3.62	2.1
Meat, eggs	3.644	8.2	14	4.05	3.8
Sugar, fats, oils	1.522	3.43	4.6	1.34	3.1
Beverages	9.049	20.4	9.0	2.62	0.3
Total	44.387	100.1	344	100.7	7.8
August 1962					
Dairy	12.017	27.8	370	67	31
Grain	6.886	14.8	60	10.9	9.4
Vegetables, leafy	0.939	2.18	7.7	1.39	8.2
Vegetables, smooth	1.403	3.25	20	3.62	14
Vegetables, root	0.618	1.43	6.2	1.12	10
Potatoes	2.565	5.94	18	3.26	7.0
Beans, dried	0.822	1.90	11	1.99	13
Fruits	3.981	9.22	18	3.26	4.5
Meat, eggs	3.709	8.59	12	2.17	3.2
Sugar, fats, oils	1.407	3.26	6.6	1.20	4.7
Beverages	9.318	21.6	22	3.99	2.4
Total	43.665	100.0	552	99.9	12.6

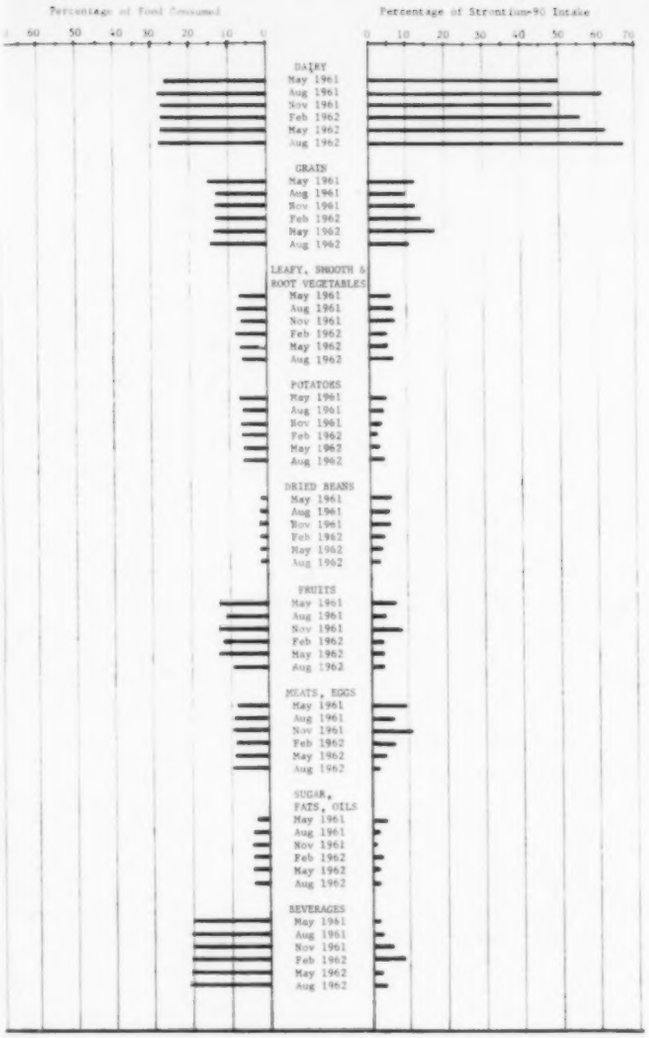


FIGURE 1.—PERCENTAGE FOOD CONSUMPTION AND PERCENTAGE STRONTIUM-90 INTAKE FROM THE CONSTITUENTS OF THE DIET (EXCLUDING DRINKING WATER) FOR WASHINGTON, D.C.

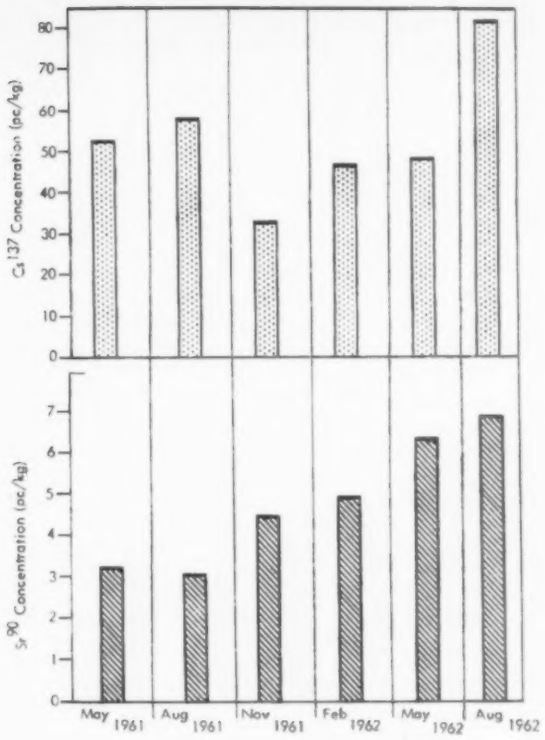


FIGURE 2.—STRONTIUM-90 AND CESIUM-137 CONCENTRATIONS IN THE TOTAL DIET (INCLUDING DRINKING WATER) FOR WASHINGTON, D.C.

Results

Table 1 presents the data for Washington, D.C. by food category from May 1961 through August 1962. Figure 1 shows percentages of the total diet by weight and percentages of the strontium–90 intake contributed by each of the 11 food categories from May 1961 through August 1962 for Washington, D.C.

Figure 2 compares for Washington, D.C. the strontium–90 and cesium–137 concentration in the total diet. No correlation between the two is immediately apparent. Table 2 displays the distribution of strontium–90 in the waste and edible portions for Washington, D.C. Strontium–90 and cesium–137 concentrations in the total diet for the various cities covering the period May 1962 through August 1962 are given in table 3.

Summary

The important observation is that dairy products, together with food items originating from grains, contribute 60 to 80 percent of the strontium–90 intake. This indicates that when one is concerned about surveillance on a nationwide scale of the intake of strontium–90

TABLE 2.—DISTRIBUTION OF STRONTIUM-90 IN WASTE AND EDIBLE PARTS OF THE TOTAL DIET (INCLUDING DRINKING WATER)

Date	Waste				Edible Food
	Edible	Inedible	Bone	Cooking water	
May 1961 (pc)	1.7	22	156	1.3	167
August 1961 (pc)	1.6	24	174	1.6	163
November 1961 (pc)	9.3	26	125	2.0	219
February 1962 (pc)	8.0	40	261	5.5	261
Average weight of constituents (kg)	0.688	1.425	0.302	0.909	52.628

TABLE 3.—STRONTIUM-90 CONCENTRATIONS IN THE TOTAL DIET (INCLUDING DRINKING WATER)

[pc/kg]

City		May 1962	August 1962
D. C:	Washington	6.4	6.9
Ga:	Atlanta	9.5	5.2
Calif:	San Francisco	3.0	3.4
Minn:	Minneapolis	4.0	8.4
Mo:	St. Louis	10	8.3

due to fallout, an estimate can be made concerning the average strontium–90 intake of an average individual by examining the strontium–90 contents of grains and dairy products. However, limited studies of the total diet would be useful in checking the above observation in every decade.

REFERENCE

(1) U.S. Department of Agriculture: *Food Consumption of Households in the United States, Report No. 1,* Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (1955), price $1.25.

SECTION III.—MILK

Milk Surveillance

PASTEURIZED MILK NETWORK
September 1962

Division of Radiological Health and
Division of Environmental Engineering and Food Protection, Public Health Service

In recognition of the importance of milk as a dietary component, the Public Health Service conducts a continuous monitoring program for radionuclides in pasteurized milk. Milk lends itself readily to a national sampling program because of its widespread and continuous availability and its ease of preparation and analysis compared to other foods.

In 1957, the PHS initiated the investigation of raw milk to determine relationships between dairy practices and radionuclide levels in milk. However, it became evident that the milk actually consumed by the population should be included in a broader sampling program. In 1960, the pasteurized milk network was initiated to provide data representative of the milk consumed in selected municipalities. Both raw and pasteurized milk sampling data were reported concurrently until June 1961 to permit comparison of the differences between the earlier, limited, milkshed sampling results and those exhibited in pasteurized milk monitoring. Since June 1961, raw milk sampling has been carried out for investigative rather than monitoring purposes.

During September 1962, pasteurized milk surveillance was conducted at 62 Pasteurized Milk Network stations with the cooperation of State and local milk sanitation agencies which have been shipping samples to the PHS Southwestern, Southeastern, and Northeastern Radiological Health Laboratories for analysis. Publication in *Radiological Health Data* follows 3 to 4 months after sample collection because of the time required for shipment, processing, radio-analysis of strontium, data compilation, and publication procedures.

Sampling and Compositing Procedures

The current program emphasizes (1) measurement of the concentrations of radioactivity in samples of pasteurized milk consumed by the public in various regions of the country, and (2) provision of at least one sampling point within virtually all States and additional points when indicated by widely varying conditions of the milk supply or when needed in order to cover large population groups. Each sample is composited from subsamples collected from each plant in proportion to the relative volumes of milk sold. The objective of this sampling program is to reflect at least 90 percent of each city's milk supply. Prior to September 15, 1961, the composite sample was taken from one day's sales per month and was as representative of a community's total supply as could be achieved under practical conditions. Since the resumption of nuclear weapons testing, the sampling schedule has been increased in frequency. During September 1962, most stations

were sampled twice a week. All surveillance data are subject to continuing review and evaluation to observe unusual patterns or concentrations which may require immediate attention. Further atmospheric nuclear testing may require re-evaluation and adjustment of the sampling frequency and analytical schedule for this program.

Iodine–131, cesium–137, and barium–140 are determined by gamma scintillation spectroscopy,[1] while strontium–89 and strontium–90

[1] Southeastern Radiological Health Laboratory employs a radiochemical procedure for barium–140 analysis.

TABLE 1.—RADIOACTIVITY IN PASTEURIZED MILK, SEPTEMBER 1962

[Average radioactivity concentrations in μμc/liter]

Sampling locations	Calcium (g/liter)		Strontium–89		Strontium–90		Iodine–131		Cesium–137		Barium–104		Sr^{90} profile in RHD
	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	
Ala: Montgomery	1.22	1.24	35	20	13	12	10	20	35	35	10	<10	Oct. 1962
Alaska: Palmer	1.08	1.17	75	175	12	14	250	730	55	80	30	90	Nov. 1962
Ariz: Phoenix	1.08	1.11	10	<5	2	2	10	10	15	10	10	<10	Jan. 1963
Ark: Little Rock	1.21	1.24	80	55	29	27	10	20	55	50	20	20	Nov. 1962
Calif: Sacramento	1.11	1.18	5	<5	3	2	20	<10	20	10	20	<10	Dec. 1962
San Francisco	1.13	1.18	10	10	4	3	20	20	20	10	20	20	Oct. 1962
Colo: Denver	1.11	1.13	55	45	15	12	30	20	75	60	10	10	Dec. 1962
Conn: Hartford	1.10	1.12	30	35	12	13	30	70	70	55	<10	<10	Dec. 1962
Del: Wilmington	1.09	1.11	40	55	13	14	30	70	70	55	<10	<10	Jan. 1963
D.C: Washington	1.16	1.18	45	30	17	18	20	60	60	55	10	10	Oct. 1962
Fla: Tampa	1.23	1.25	20	20	11	12	<10	<10	145	140	<10	<10	Jan. 1963
Ga: Atlanta	1.23	1.23	45	35	19	17	20	10	55	50	10	<10	Sep. 1962
Hawaii: Honolulu	1.07	1.15	10	10	4	3	10	10	35	30	<10	<10	Nov. 1962
Idaho: Idaho Falls	1.09	1.15	45	30	11	11	40	40	75	60	20	20	Jan. 1963
Ill: Chicago	1.14	1.17	35	40	14	15	50	100	60	50	<10	10	Oct. 1962
Ind: Indianapolis	1.11	1.10	40	45	16	21	30	70	40	30	<10	<10	Dec. 1962
Iowa: Des Moines	1.10	1.18	80	65	14	13	60	120	40	35	20	20	Jan. 1963
Kans: Wichita	1.12	1.17	60	45	13	12	40	30	40	35	10	<10	Nov. 1962
Ky: Louisville	1.19	1.23	75	55	22	24	20	40	35	30	20	20	Jan. 1963
La: New Orleans	1.22	1.24	75	55	30	28	10	<10	80	70	20	10	Nov. 1962
Maine: Portland	1.15	1.10	45	60	15	14	30	60	120	105	<10	<10	Jan. 1963
Md: Baltimore	1.16	1.19	40	35	12	18	20	60	60	60	<10	10	Jan. 1963
Mass: Boston	1.12	1.11	45	50	21	25	30	70	125	105	10	20	Oct. 1962
Mich: Detroit	1.10	1.12	35	50	12	11	50	120	70	55	<10	10	Dec. 1962
Grand Rapids	1.15	1.14	35	45	10	9	40	70	60	55	<10	<10	Jan. 1963
Minn: Minneapolis	1.10	1.16	85	85	21	19	40	100	95	90	20	30	Oct. 1962
Miss: Jackson	1.26	1.27	70	45	21	18	10	<10	45	35	20	<10	Dec. 1962
Mo: Kansas City	1.07	1.14	80	55	14	13	50	60	35	30	20	20	Dec. 1962
St. Louis	1.08	1.17	60	40	16	12	40	50	40	35	20	20	Nov. 1962
Mont: Helena	1.14	1.20	80	55	15	17	50	90	85	85	20	20	Nov. 1962
Nebr: Omaha	1.12	1.20	85	60	14	14	60	80	50	50	20	20	Jan. 1963
Nev: Las Vegas *	1.06	1.10	25	35	5	5	30	20	35	20	<10	<10	*
N.H: Manchester	1.13	1.12	45	65	17	17	30	60	145	115	<10	10	Jan. 1963
N.J: Trenton	1.12	1.13	35	45	12	18	20	50	65	60	<10	10	Dec. 1962
N. Mex: Albuquerque	1.10	1.17	20	15	5	4	30	20	25	15	10	<10	Nov. 1962
N.Y: Buffalo	1.10	1.10	35	55	15	14	40	100	70	65	<10	10	Dec. 1962
New York	1.08	1.14	40	45	16	20	40	90	80	70	<10	10	Oct. 1962
Syracuse	1.11	1.10	40	60	12	15	40	90	60	50	10	20	Nov. 1962
N.C: Charlotte	1.23	1.26	55	40	23	20	<10	<10	50	45	10	10	Nov. 1962
N.D: Minot	1.11	1.15	100	80	22	19	80	170	80	75	20	30	Jan. 1963
Ohio: Cincinnati	1.12	1.13	45	55	13	12	40	80	40	30	<10	<10	Dec. 1962
Cleveland	1.11	1.12	30	35	14	16	40	90	55	50	<10	10	Nov. 1962
Okla: Oklahoma City	1.16	1.20	60	35	17	18	20	20	45	40	10	10	Oct. 1962
Ore: Portland	1.12	1.22	60	25	12	11	20	30	65	55	10	10	Dec. 1962
Pa: Philadelphia	1.14	1.15	30	35	14	17	30	60	70	65	<10	<10	Nov. 1962
Pittsburgh	1.12	1.12	40	45	18	19	30	70	85	70	<10	10	Nov. 1962
P.R: San Juan	1.19	1.20	25	20	11	10	<10	<10	35	30	10	<10	Nov. 1962
R.I: Providence	1.11	1.09	35	40	13	14	20	50	85	80	<10	10	Jan. 1963
S.C: Charleston	1.21	1.24	45	25	20	20	10	10	65	65	<10	<10	Dec. 1962
S.D: Rapid City	1.06	1.12	85	55	20	14	70	130	60	65	20	20	Oct. 1962
Tenn: Chattanooga	1.25	1.28	65	40	23	19	10	20	55	45	10	10	Oct. 1962
Memphis	1.22	1.23	60	40	21	20	10	20	25	25	20	20	Jan. 1963
Tex. Austin	1.16	1.16	15	10	6	5	<10	<10	20	15	<10	<10	Oct. 1962
Dallas	1.18	1.19	40	25	14	12	10	<10	30	25	<10	<10	Dec. 1962
Utah: Salt Lake City	1.10	1.19	60	35	12	10	320	40	95	60	40	20	Nov. 1962
Vt: Burlington	1.10	1.12	45	65	14	17	20	60	110	105	<10	10	Dec. 1962
Va: Norfolk	1.20	1.24	55	35	22	21	10	20	75	55	<10	<10	Dec. 1962
Wash: Seattle	1.10	1.18	45	45	15	18	30	30	90	75	20	20	Oct. 1962
Spokane	1.15	1.18	40	30	14	12	50	60	70	65	10	10	Dec. 1962
W. Va: Charleston	1.16	1.19	80	50	24	21	20	30	45	35	10	10	Oct. 1962
Wis: Milwaukee	1.10	1.12	30	40	9	8	50	120	60	50	<10	<10	Jan. 1963
Wyo: Laramie	1.11	1.18	125	95	15	13	190	40	110	90	50	20	Jan. 1963
Network average	1.14	1.17	49	44	14.8	14.5	40	62	62	54	12	13	

* Las Vegas entered the network in July 1962.

are determined following radiochemical separation. The minimum detectable concentrations in units of μμc/liter are: Sr^{89}, 5; Sr^{90}, 1; I^{131}, 10; Cs^{137}, 5; and Ba^{140}, 10.

Table 1 presents summaries of all available analyses for September 1962. When a radionuclide is reported by a laboratory as being below the minimum detectable concentration, one-half of this value is used in calculating the monthly average. A similar procedure is used for the network average.

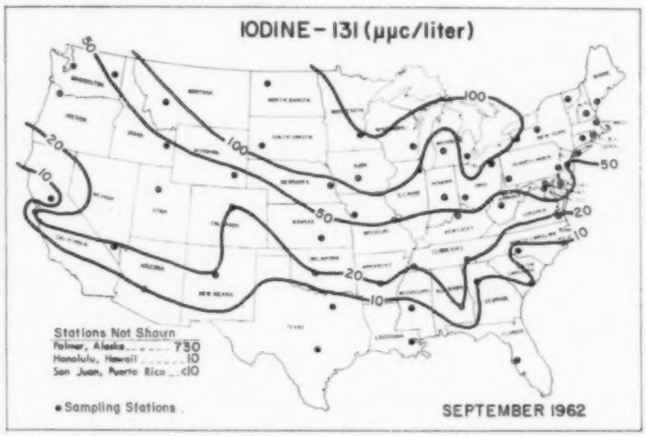


FIGURE 1.—IODINE–131 CONCENTRATIONS IN PASTEURIZED MILK

Discussion of the Data

Iodine–131 September 1962 average concentration contours generally ran in an east-west direction (see figure 1). Only the southernmost part of the country had concentrations of iodine–131 below 10 μμc/liter. The northernmost part of the country had concentrations in excess of 100 μμc/liter. The station having the highest September average was Palmer, Alaska with 730 μμc/liter.

Strontium–89 September average concentration contours appeared somewhat like iodine–131 contours in that the intrusion of both radionuclides is from the north (see figure 2). Strontium–89 concentrations in milk were greater than 50 μμc/liter in the northern part of the country. The station with the highest September average was Palmer, Alaska with 175 μμc/liter.

Strontium–90 September average concentrations in milk were generally between 10 and 20 μμc/liter over the United States (see figure

FIGURE 2.—STRONTIUM–89 CONCENTRATIONS IN PASTEURIZED MILK

3). The Southwest reported concentrations less than 10 μμc/liter. Strontium–90 concentrations greater than 20 μμc/liter occurred in the lower Mississippi Valley and in the North Carolina, Kentucky, West Virginia and Virginia area. The strontium–90 contour map for September appears similar to the one for August. The station reporting the highest September average strontium–90 concentration was New Orleans with 28 μμc/liter.

FIGURE 3.—STRONTIUM–90 CONCENTRATIONS IN PASTEURIZED MILK

Selected Monthly Strontium–90 Profiles

In previous issues of *RHD*, the average monthly strontium–90 concentrations in pasteurized milk from selected cities in the monitoring program were published. Profiles for an additional 16 cities are presented in figure 4. These graphs show the strontium–90 concentrations in milk from selected cities in the United States Department of Agriculture marketing regions of the United States.

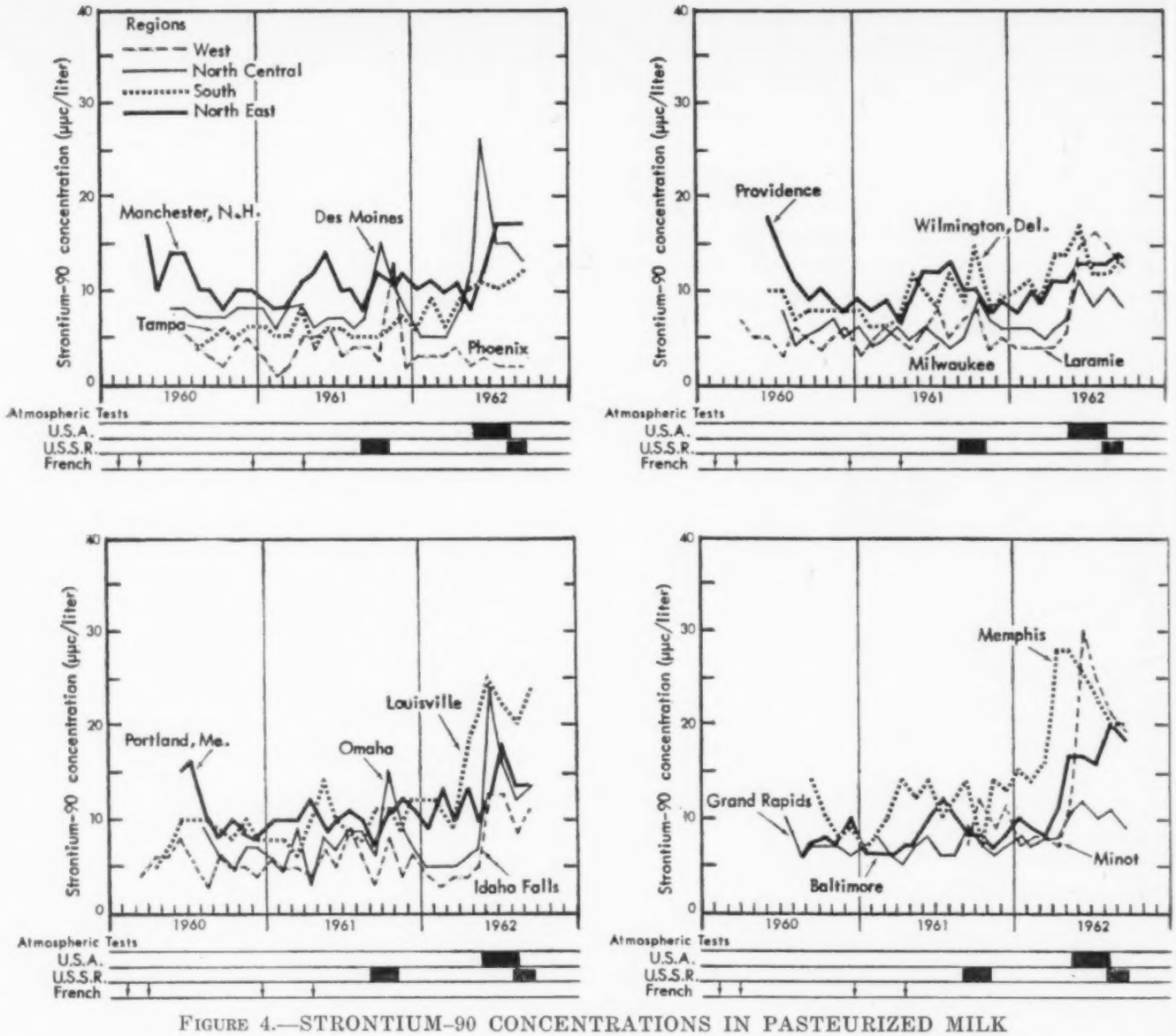


FIGURE 4.—STRONTIUM-90 CONCENTRATIONS IN PASTEURIZED MILK

INDIANA MILK NETWORK
September–October 1962

Bureau of Environmental Sanitation
Indiana State Board of Health

In September 1961, the Indiana State Board of Health initiated a program of milk sampling for radiological analyses. Indiana was geographically divided into five major milksheds and one large dairy within each milkshed was selected as a sampling station (see figure 5).

The milk samples are routinely analyzed for iodine–131, cesium–137, barium-lanthanum–140, strontium–89, and strontium–90. Analyses for iodine–131, cesium–137, and barium-lantha-

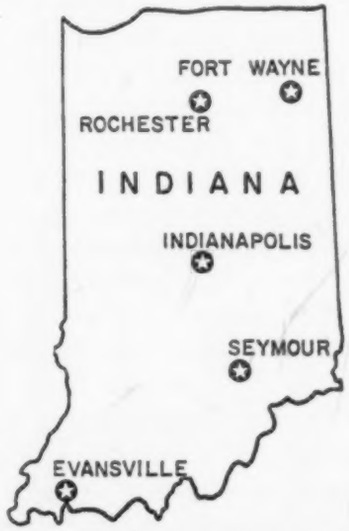


FIGURE 5.—INDIANA MILK SAMPLING LOCATIONS

TABLE 2.—INDIANA MILK NETWORK, SEPTEMBER–OCTOBER 1962

[Concentrations in μμc/liter]

Sampling locations	Strontium–89		Strontium–90		Iodine–131		Cesium–137		Barium–140	
	Sep. 1962	Oct. 1962	Sep. 1962	Oct. 1962	Sep. 1962	Oct. 1962	Sep. 1962	Oct. 1962	Sep. 1962	Oct. 1962
Evansville	160	95	25	14	70	80	20	35	<10	10
Fort Wayne	80	60	8	19	150	70	40	45	10	<10
Indianapolis	—	80	—	5	90	40	30	40	10	10
Rochester	140	85	12	13	130	70	40	50	10	<10
Seymour	140	100	5	4	60	40	35	40	10	<10
State average	130	85	12	11	100	60	35	40	10	<10

num–140 are conducted on a weekly basis except when iodine–131 results exceed 100 μμc/liter, at which time the frequency of sampling is increased. Samples which are analyzed for strontium–90 are composited weekly and analyzed monthly.

The trichloroacetic acid analytical procedure (*1*) is used for strontium–89 and strontium–90 analyses. A 512–channel pulse height analyzer and shielded 4″ x 4″ sodium iodide crystal are used for the gamma scintillation analysis of iodine–131, cesium–137, and barium-lanthanum–140.

The monthly averages of the data obtained for the individual sampling stations and the State averages are reported in table 2. The State average is an arithmetic average of the station values.

REFERENCE

(*1*) Robert A. Taft Sanitary Engineering Center, Public Health Service: *Radionuclide Analysis of Environmental Samples*, Technical Report, R59–6: 55–E–1 (November 16, 1959).

OREGON MILK NETWORK
July–October 1962

Division of Sanitation and Engineering
Oregon State Board of Health

With the cooperation of the Oregon State Department of Agriculture and the Oregon State University, the Oregon State Board of Health initiated a milk monitoring network in March 1962. Two 1–quart samples of packaged homogenized pasteurized milk are collected on a monthly basis by the Oregon Department of Agriculture and the City of Portland from seven milk districts throughout the State (see figure 6). Accelerated sampling on a weekly basis is performed when iodine–131 concentrations in milk exceed 100 pc/liter. The samples are forwarded to the Oregon State Board of Health radiation laboratory for iodine–131 and cesium–137 analyses. The analyses are performed utilizing a 3″ x 3″ sodium iodide scintillation crystal and a 512–channel pulse-height analyzer. All milk samples, after being gamma scanned, are frozen and stored for future strontium–90 analyses. Calibration is underway for barium–140 analysis.

FIGURE 6.—OREGON PASTEURIZED MILK NETWORK SAMPLING STATIONS

Table 3 presents the Oregon milk monitoring data. During the period from March through June 1962, the milk samples analyzed

TABLE 3.—RADIONUCLIDE CONCENTRATIONS IN OREGON MILK, JULY–OCTOBER 1962

[Average concentrations in pc/liter]

Station and radionuclide	July	August	September	October
Portland (composite)				
Iodine-131	<15	20	40	80
Cesium-137	70	70	55	105
Portland (local producer)				
Iodine-131	<15	15	35	50
Cesium-137	55	60	55	70
Tillamook				
Iodine-131	[a] <15	[a] <15	[a] 30	140
Cesium-137	[a] 100	[a] 145	[a] 80	220
Medford				
Iodine-131	[a] <15	[a] <15	[a] 30	[a] 100
Cesium-137	[a] 35	[a] 15	[a] 20	[a] 50
Redmond				
Iodine-131	[a] <15	[a] <15	105	65
Cesium-137	[a] 40	[a] 40	45	40
Eugene				
Iodine-131	[a] <15	[a] 15	[a] 20	[a] 30
Cesium-137	[a] 30	[a] 30	[a] 50	[a] 80
Baker				
Iodine-131	[a] 40	[a] <15	100	75
Cesium-137	[a] 60	[a] 85	50	50
Nyssa				
Iodine-131	—	[a] <15	50	[a] 50
Cesium-137	—	[a] 60	55	[a] 50

[a] Based on one sample, all others more than one.

by the State Board of Health for iodine–131 had concentrations less than the minimum detectable concentration of 15 pc/liter.

As a continuing check on the validity of the data, a split sample of the official U.S. Public Health Service pasteurized milk sample from Portland is obtained on a weekly basis for analysis. These data are compared to the Public Health Service data in figure 7.

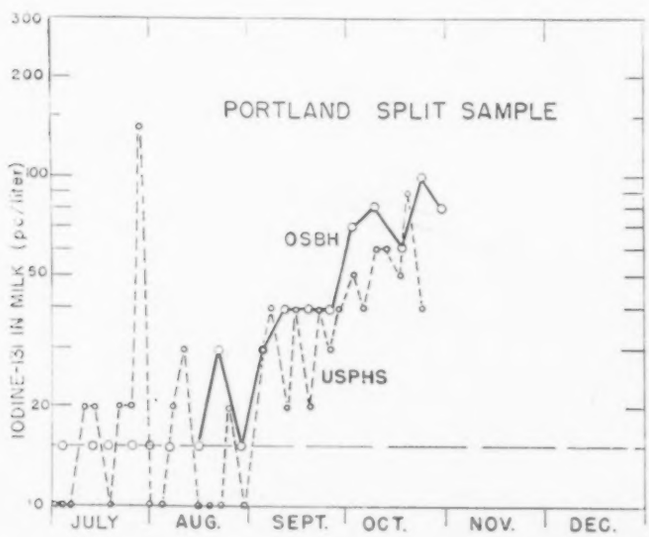


FIGURE 7.—COMPARISON OF PUBLIC HEALTH SERVICE AND OREGON STATE BOARD OF HEALTH MILK ANALYSES FOR PORTLAND, 1962

RADIOSTRONTIUM IN MILK (*1*)
March–June 1962

Health and Safety Laboratory
U.S. Atomic Energy Commission

The Health and Safety Laboratory (HASL) began monitoring liquid whole milk in New York City in 1954 for strontium–90 in order to estimate the dietary contribution from the ingestion of radiostrontium in milk. Subsequently, powdered milk monitoring was initiated at Perry, New York, and at Mandan, North Dakota. Liquid whole milk monitoring was started in Honolulu, Hawaii in August 1959.

The New York City sample is a monthly composite of pasteurized milk purchased daily in quart containers at retail stores. Five large dairies are represented in the sample. The Honolulu sample is a monthly composite of pasteurized milk collected weekly. Samples from two dairies are analyzed and the results are averaged. The Mandan and Perry samples are monthly composites of powdered milk collected in 5–pound lots from plants in each city. The Mandan sample is powdered buttermilk used for cattle feed, while the Perry sample is powdered whole milk used for human con-

TABLE 4.—RADIOSTRONTIUM AND CALCIUM IN LIQUID MILK, MARCH–JUNE 1962

Sampling station and period	Calcium (g/liter)	Strontium-90 (μμc/liter)	Strontium-90 (μμc/g Ca)	Sr^{89}/Sr^{90} [a]
New York City				
1959 Average			11	
1960 Average			8.0	
1961 Average			6.7	
1962 March	1.23	4.9	4.0	1
April	1.02	9.3	9.1	10
May	1.26	18 7	14.8	6
June	1.00	8 9	8.9	8
Honolulu, Hawaii				
1959 Average			5.0	
1960 Average			3.2	
1961 Average			2.4	
1962 March	1.06	3.3	3.1	10
April	1.05	5.2	4.8	8
May	1.14	4.8	4.2	6
June	1.10	3.5	3.2	6

[a] Strontium-89 value extrapolated to the midpoint of sampling period.

sumption. The Honolulu data are of interest since the cows there are on pasture throughout the year and soil analyses have shown strontium–90 concentrations in soils in Hawaii to be comparable with those in the New York area (*2*).

Strontium–89 became measurable in September 1961, indicating that fresh fission products from the U.S.S.R. nuclear test series were being deposited. The Sr^{89}/Sr^{90} ratios are presented in tables 4 and 5, as are the calcium and strontium data for March 1962 through June 1962. The fluctuations of strontium–90 with time are shown in figures 8 and 9.

TABLE 5.—RADIOSTRONTIUM AND CALCIUM IN POWDERED MILK AND BUTTERMILK, MARCH–JUNE 1962

Sampling station and period	Calcium (g/kg)	Strontium-90 (μμc/kg)	Strontium-90 (μμc/g Ca)	Sr^{89}/Sr^{90} [a]
Powdered milk				
Perry, New York				
1959 Average			8.0	
1960 Average			6.5	
1961 Average			6.2	
1962 March	8.9	50	5.6	1
April	9.1	51	5.6	1
May	9.6	84	8.8	3
June	9.0	116	13.0	4
Powdered buttermilk				
Mandan, North Dakota				
1959 Average			25.7	
1960 Average			15.0	
1961 Average			9.4	
1962 March	11.4	181	16.0	1
April	13.1	270	20.6	2
May	11.6	333	28.7	8
June	11.0	316	28.8	7

[a] Strontium-89 value extrapolated to the midpoint of sampling period.

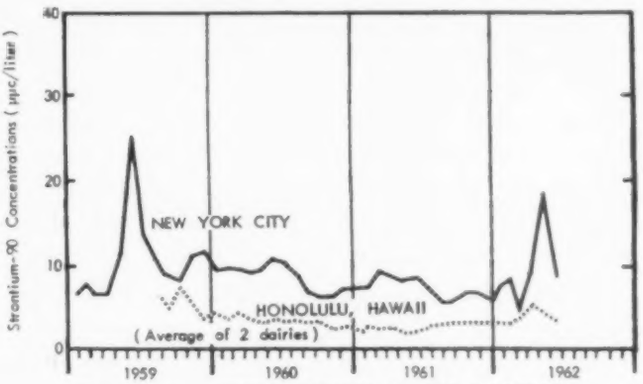


FIGURE 8.—STRONTIUM–90 IN LIQUID MILK SAMPLES

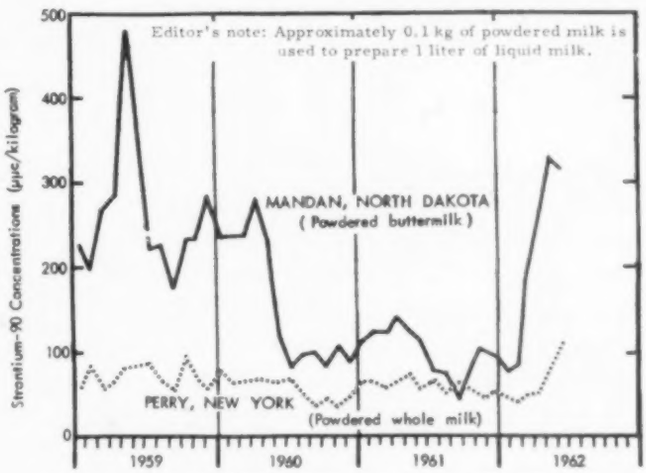


FIGURE 9.—STRONTIUM–90 IN POWDERED MILK SAMPLES

REFERENCES

(*1*) U.S. Atomic Energy Commission: *Fallout Program Quarterly Summary Report, HASL–131,* Office of Technical Services, Department of Commerce, Washington 25, D.C. (October 1, 1962), price $3.50.

(*2*) U.S. Atomic Energy Commission: *Summary of Available Data on the Strontium–90 Content of Foods and of Total Diets in the United States, HASL–90*:4, Office of Technical Services, Department of Commerce, Washington 25, D.C. (August 18, 1960).

Previous coverage in *Radiological Health Data:*

Period	Issue
December 1960–April 1961	*December 1961*
May–July 1961	*March 1962*
August–December 1961	*June 1962*
January–February 1962	*September 1962*

RADIONUCLIDES IN CANADIAN DRIED MILK PRODUCTS
Second Quarter 1962

Radioactive Fallout Study Program
Department of National Health and Welfare, Ottawa, Canada

Beginning in November 1955, radiochemical analyses of skim milk and buttermilk powders for strontium–90 concentrations were initiated by the Department of National Health and Welfare. Since April 1962, analyses for strontium–89 and cesium–137 have also been included.

Samples are collected through the cooperation of the Marketing Division of the Canadian Department of Agriculture, whose dairy products inspectors pick up four 1–pound samples of dried milk from each station on a monthly schedule.

No statistical plan is followed for sample collection. Because of uncertainties introduced by this method of sampling, the significance of differences between station-to-station and month-to-month results is not precisely known. However, it is possible to consider all results for a given period of time as being sufficiently random in selection to show any national trend when average values for such periods and all stations are plotted, as in figure 11. It should be emphasized that average concentrations over a considerable period of time are more meaningful from the public health point of view than fluctuating monthly concentrations.

A detailed discussion of the sampling and radiochemical procedures employed may be found in the Department's publication (*1*). Table 6 presents the results of measurements of strontium–89, strontium–90 and cesium–137 in Canadian dried milk powder for the second quarter of 1962. These data were taken from the "Quarterly Report of the Radioactive Fall-

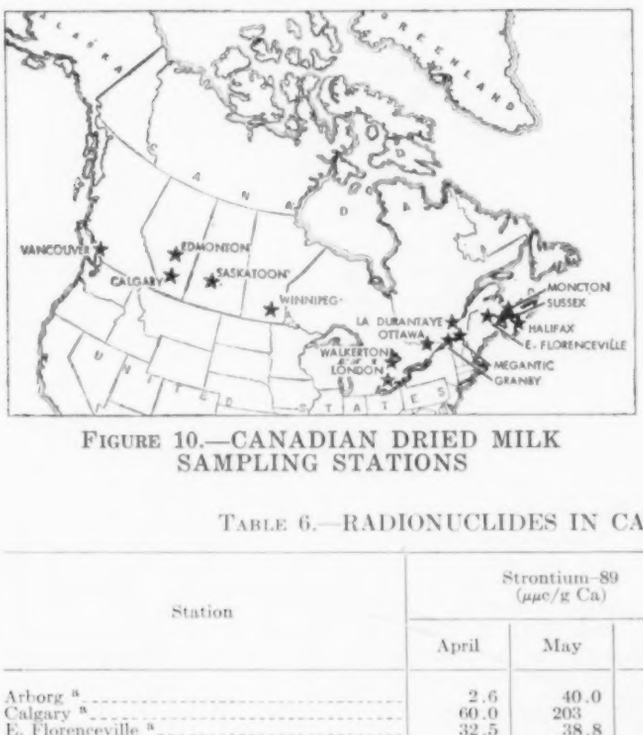


FIGURE 10.—CANADIAN DRIED MILK SAMPLING STATIONS

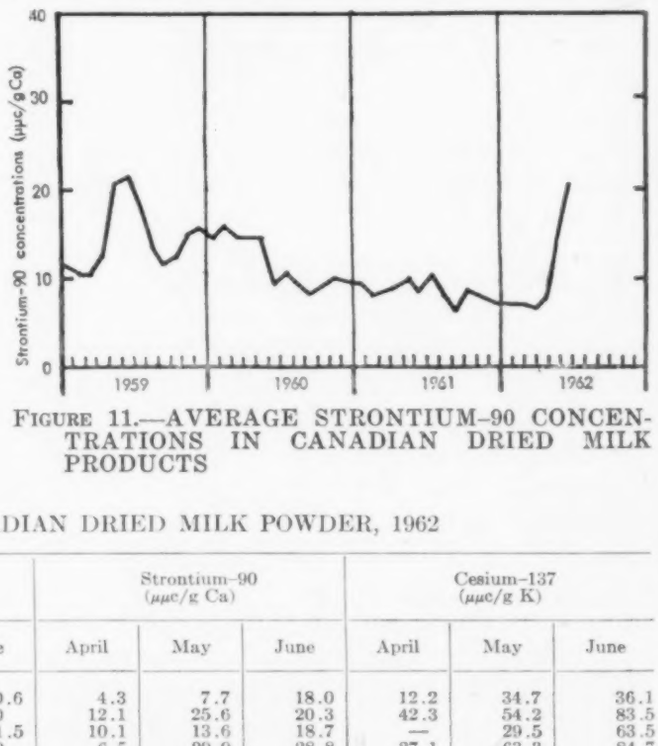


FIGURE 11.—AVERAGE STRONTIUM–90 CONCENTRATIONS IN CANADIAN DRIED MILK PRODUCTS

TABLE 6.—RADIONUCLIDES IN CANADIAN DRIED MILK POWDER, 1962

Station	Strontium–89 (μμc/g Ca)			Strontium–90 (μμc/g Ca)			Cesium–137 (μμc/g K)		
	April	May	June	April	May	June	April	May	June
Arborg [a]	2.6	40.0	90.6	4.3	7.7	18.0	12.2	34.7	36.1
Calgary [a]	60.0	203	240	12.1	25.6	20.3	42.3	54.2	83.5
E. Florenceville [a]	32.5	38.8	81.5	10.1	13.6	18.7	—	29.5	63.5
Edmonton	29.6	254	210	6.5	29.0	28.8	27.1	63.3	84.7
Grunthal	2.7	148	129	3.9	14.8	18.6	4.2	47.7	60.7
Halifax	0	29.6	46.0	6.7	9.9	21.9	10.4	28.8	80.5
La Durantaye	—	2.2	127	—	10.8	26.3	—	25.0	101
Lawrenceville	0	3.6	118	11.8	12.9	23.8	36.2	—	153.4
London	1.7	25.7	75.1	3.3	5.7	9.7	5.1	16.4	60.0
Megantic	0.5	36.3	136	16.0	18.6	38.2	28.6	52.0	114.7
Moncton	1.3	16.6	126	7.4	10.0	27.8	19.4	25.0	72.2
Nicolet	1.1	6.8	48.1	6.1	7.9	8.6	17.6	34.9	42.1
Ottawa	10.4	22.2	49.4	8.2	7.2	10.7	—	17.6	42.9
Saskatoon [a]	15.0	154	125	6.0	18.4	19.5	5.7	32.3	47.6
Sussex	1.2	3.7	84.5	8.9	7.8	19.8	14.4	—	58.1
Vancouver	62.4	223	101	12.3	23.0	24.5	51.3	—	144.6
Walkerton	5.4	86.2	124	6.3	9.8	8.8	10.2	37.6	77.7
Average	14.2	76.1	112	8.1	13.7	20.2	20.3	35.6	77.8

[a] Buttermilk—All other samples were skim milk powders

out Monitoring Program," dated August 1962, published by the Radiation Protection Division of the Department of National Health and Welfare.

The strontium–90 concentrations in milk increased during the second quarter of 1962. The maximum average of all stations during the quarter was 20.2 μμc/g Ca in June. The Canadian average for the preceding twelve-month period was 9.3 μμc/g Ca, and the previous record high of 21.3 μμc/g Ca occurred in June 1959.

For an approximate method to compare the Canadian powdered milk data in units of μμc/g Ca to other milk data in units of μμc/liter, it can be assumed that milk has approximately 1.2 g Ca/liter of liquid milk. Canadian powdered milk data may be compared to liquid milk data by multiplying the former values by 0.8.

REFERENCE

(*1*) Radiation Protection Division, Department of National Health and Welfare, Ottawa, Canada: *Preliminary Report on the Measurements of Radioactive Strontium in Canadian Milk Powder Samples, CNHW (RP–1)*, (July 1958).

Twelve-Month Sum of Daily Radionuclide Content of One Liter of Pasteurized Milk

November 1961–October 1962: Iodine–131
October 1961–September 1962: Strontium–89 and Strontium–90

Division of Radiological Health, Public Health Service

The guidance of the Federal Radiation Council is given in terms of transient rates of intake of radioactive materials in micromicrocuries per day. The ranges are based on radiation doses considered acceptable for lifetime exposure from normal peacetime atomic industry operations. The Council recommends the use of a time period of one year as an appropriate interval for averaging exposures. The Council has recently emphasized that the annual acceptable exposure dose is not a "danger point" which, if exceeded, requires protective measures (*1*, *2*, *3*).

To facilitate comparison of the concentrations of certain radionuclides in milk with the Radiation Protection Guides, tables 1 and 2 below furnish a means towards estimating the contribution of milk to the total dietary intake of iodine–131, strontium–89, and strontium–90. The tables are based on the same data which are used for computing the Pasteurized Milk Network monthly averages. They present index values which are the estimated sums of the daily amounts of a radionuclide in one liter of milk for a 12–month period.

The tables show 12–month index values for each of the Network's 62 sampling locations. Due to the longer time required for strontium–89 and strontium–90 analysis, these 12–month index values are for the year beginning one month earlier than the iodine–131 values. The columns of monthly index values in each table are used to compute the net change as the yearly index values are advanced by one month. The following column shows this new 12–month index value. In addition, the first column in table 1 gives the iodine–131 October concentration averages.

The data in tables 1 and 2 are calculated as follows: (a) results from all samples collected in each week (Sunday through Saturday) are averaged, (b) the weekly averages for all weeks ending within a given month are averaged and an average for the month is obtained, and (c) the monthly radionuclide index value is determined by multiplying the average for the month by the number of days in the month. The number of days in the month will be either 28 or 35, corresponding to the complete calendar weeks used for any month. Procedures exemplified by (a) and (b) above minimize the effect of any one day's sample results on the average for the month, particularly for a short-lived radionuclide such as iodine–131.

For a number of reasons it is desirable to have a standard quantity of milk to use in the development of index values for the different radionuclides. In the case of strontium, 1 liter is a suitable quantity as this amount of milk supplies approximately 1 gram of calcium, the

amount used by the Federal Radiation Council in deriving the intake guidance for strontium. In the case of iodine–131, the critical age group is the young infant. Available information suggests that the average milk consumption of infants in the 6–18 month group is not more than 1 liter per day. Thus the index value based on 1 liter of milk, though not directly an average intake value, is probably the most useful index for estimating total intake.

TABLE 1.—TWELVE-MONTH SUM OF DAILY AMOUNTS OF IODINE–131 IN ONE LITER OF MILK

Sampling locations		Oct. 1962 iodine–131 averages (μμc/liter)	Iodine–131 index values (μμc day/liter)[a]			
			Oct 1961–Sep 1962	Oct 1961	Sep 30, 1962–Oct 27, 1962	Nov 1961–Oct 1962
Ala:	Montgomery	10	4,450	930	280	3,800
Alaska:	Palmer	270	39,660	10,230	7,560	36,990
Ariz:	Phoenix	10	7,010	1,860	280	5,430
Ark:	Little Rock	50	11,960	3,720	1,400	9,640
Calif:	Sacramento	10	4,640	620	280	4,300
	San Francisco	10	4,690	620	280	4,350
Colo:	Denver	20	8,570	2,790	560	6,340
Conn:	Hartford	70	6,880	1,860	1,960	6,980
Del:	Wilmington	70	8,270	1,860	1,960	8,370
D.C.:	Washington	60	6,540	1,860	1,680	6,360
Fla:	Tampa	10	4,610	1,240	280	3,650
Ga:	Atlanta	20	7,140	2,480	560	5,220
Hawaii:	Honolulu	<10	4,190	620	140	3,710
Idaho:	Idaho Falls	40	13,670	4,340	1,120	10,450
Ill:	Chicago	120	14,860	4,650	3,360	13,570
Ind:	Indianapolis	90	9,360	2,170	2,520	9,710
Iowa:	Des Moines	120	28,250	8,990	3,360	22,620
Kans:	Wichita	60	23,890	4,030	1,680	21,540
Ky:	Louisville	40	9,490	2,790	1,120	7,820
La:	New Orleans	30	7,320	2,480	840	5,680
Maine:	Portland	60	8,810	3,720	1,680	6,770
Md:	Baltimore	60	7,100	2,170	1,680	6,610
Mass:	Boston	90	9,500	4,030	2,520	7,990
Mich:	Detroit	120	15,750	6,510	3,360	12,600
	Grand Rapids	90	9,410	2,790	2,520	9,140
Minn:	Minneapolis	100	25,360	10,540	2,800	17,620
Miss:	Jackson	20	8,250	2,790	560	6,020
Mo:	Kansas City	80	31,250	4,650	2,240	28,840
	St. Louis	60	15,410	4,960	1,680	12,130
Mont:	Helena	70	16,300	4,960	1,960	13,300
Nebr:	Omaha	80	23,020	7,750	2,240	17,510
Nev:	Las Vegas[b]	20	2,940	[c] —	560	3,500
N.H.:	Manchester	70	8,320	3,100	1,960	7,180
N.J.:	Trenton	60	6,940	2,790	1,680	5,830
N. Mex.:	Albuquerque	20	7,220	930	560	6,850
N.Y.:	Buffalo	90	9,150	3,100	2,520	8,570
	New York	130	9,540	3,100	3,640	10,080
	Syracuse	100	11,110	4,340	2,800	9,570
N.C.:	Charlotte	10	3,550	1,240	280	2,590
N.D.:	Minot	100	15,040	4,340	2,800	13,500
Ohio:	Cincinnati	80	12,180	3,100	2,240	11,320
	Cleveland	100	9,420	3,100	2,800	9,120
Okla:	Oklahoma City	30	17,130	2,790	840	15,180
Ore:	Portland	60	11,230	1,860	1,680	11,050
Pa:	Philadelphia	70	7,870	2,480	1,960	7,350
	Pittsburgh	110	8,930	2,790	3,080	9,220
P.R.:	San Juan	<10	4,470	620	140	3,990
R.I.:	Providence	70	7,680	2,480	1,960	7,160
S.C.:	Charleston	20	4,810	1,860	560	3,510
S.D.:	Rapid City[d]	80	7,950	—	2,240	10,190
Tenn.:	Chattanooga	20	6,930	2,480	560	5,010
	Memphis	40	10,810	4,960	1,120	6,970
Tex.:	Austin	10	4,730	930	280	4,080
	Dallas	30	7,640	1,240	840	7,240
Utah:	Salt Lake City	60	34,240	3,720	1,680	32,200
Vt.:	Burlington	100	8,200	3,100	2,800	7,900
Va.:	Norfolk	40	5,900	2,480	1,120	4,540
Wash:	Seattle	60	12,030	3,720	1,680	9,990
	Spokane	40	24,090	3,720	1,120	21,490
W. Va.:	Charleston	30	5,950	1,860	840	4,930
Wis.:	Milwaukee	140	14,110	4,650	3,920	13,380
Wyo.:	Laramie	30	20,990	1,240	840	20,590

[a] The data in this table are index values, not to be interpreted as consumption or total intake values. Annual I^{131} intake per person may be calculated from an index value in this table by applying the appropriate factor representing average individual daily milk consumption for any selected group under consideration.

Example: 12-month I^{131} index (μμc day/liter) × milk consumption factor (liter/day/person) = 12-month I^{131} intake (μμc/person)

[b] Station began operation in July 1962.
[c] Dash indicates no data available.
[d] Station began operation in January 1962.

REFERENCES

(*1*) Chadwick, Donald R., and Conrad P. Straub: Considerations in Establishing Radiation Protection Standards for Radioactivity in the Environment, *Radiological Health Data, 3*:159–65 (May 1962).

(*2*) Federal Radiation Council: *Background Material for the Development of Radiation Protection Standards, Report No. 2*, Superintendent of Documents, U.S. Government Printing Office (September 1961), price 20 cents.

(*3*) Public Health Service: *Radiological Health Data, 3*:ii–iii (September 1962).

TABLE 2.—TWELVE-MONTH SUM OF DAILY AMOUNTS OF STRONTIUM-89 AND STRONTIUM-90 IN ONE LITER OF MILK

Sampling locations		Strontium-89 index values (μμc day/liter)[a]				Strontium-90 index values (μμc day/liter)[a]			
		Sep 1961–Aug 1962	Sep 1961	Aug 26, 1962–Sep 29, 1962	Oct 1961–Sep 1962	Sep 1961–Aug 1962	Sep 1961	Aug 26, 1962–Sep 29, 1962	Oct 1961–Sep 1962
Ala:	Montgomery[b]	[c] 18,065	[d] —	700	18,765	4,087	—	420	4,507
Alaska:	Palmer	[c] 10,775	—	6,125	16,900	3,233	210	490	3,513
Ariz:	Phoenix	[c] 5,100	—	90	5,190	1,292	120	70	1,242
Ark:	Little Rock	[c] 41,220	—	1,925	43,145	8,890	480	945	9,355
Calif:	Sacramento	6,675	750	90	6,015	1,570	180	70	1,460
	San Francisco	[c] 10,170	—	350	10,520	1,844	120	105	1,829
Colo:	Denver	9,215	150	1,575	10,640	2,839	150	420	3,109
Conn:	Hartford	[c] 5,715	—	1,225	6,940	3,410	210	455	3,655
Del:	Wilmington	[c] 11,215	—	1,925	13,140	4,189	270	490	4,409
D.C:	Washington	11,330	300	1,050	12,080	3,937	210	630	4,357
Fla:	Tampa	7,235	80	700	7,855	2,831	150	420	3,101
Ga:	Atlanta	26,740	150	1,225	27,815	5,601	270	595	5,926
Hawaii:	Honolulu	[c] 8,770	—	350	9,120	1,914	210	105	1,809
Idaho:	Idaho Falls	[c] 7,905	—	1,050	8,955	2,299	90	385	2,594
Ill:	Chicago	10,740	600	1,400	11,540	3,116	150	525	3,491
Ind:	Indianapolis	[c] 11,060	—	1,575	12,635	3,880	180	735	4,435
Iowa:	Des Moines	[c] 20,535	—	2,275	22,810	4,013	210	455	4,258
Kans:	Wichita	[c] 15,335	—	1,575	16,910	3,760	390	420	3,790
Ky:	Louisville	[c] 21,150	—	1,925	23,075	5,400	330	840	5,910
La:	New Orleans	63,905	300	1,925	65,530	9,464	390	980	10,054
Maine:	Portland	10,455	600	2,100	11,955	4,204	210	490	4,484
Md:	Baltimore	[e] 9,940	—	1,225	11,165	4,145	240	630	4,535
Mass:	Boston	[c] 11,035	—	1,750	12,785	4,424	270	875	5,029
Mich:	Detroit	[c] 7,835	—	1,750	9,585	2,999	180	385	3,204
	Grand Rapids	[c] 9,360	—	1,575	10,935	3,116	270	315	3,161
Minn:	Minneapolis	[c] 21,055	—	2,975	24,030	4,347	150	665	4,862
Miss:	Jackson	54,635	300	1,575	55,910	8,083	390	630	8,323
Mo:	Kansas City	[c] 26,465	—	1,925	28,390	4,258	210	455	4,503
	St. Louis	16,855	900	1,400	17,355	4,307	300	420	4,427
Mont:	Helena	[c] 11,585	—	1,925	13,510	3,133	300	595	3,428
Nebr:	Omaha	[c] 22,155	—	2,100	24,255	3,846	180	490	4,156
Nev:	Las Vegas[e]	[c] 1,120	—	1,225	2,345	252	—	175	427
N.H:	Manchester	[c] 7,110	—	2,275	9,385	4,146	240	595	4,501
N.J:	Trenton	[c] 7,310	—	1,575	8,885	3,268	240	630	3,658
N. Mex:	Albuquerque	[c] 4,150	—	525	4,675	1,595	90	140	1,645
N.Y:	Buffalo	[c] 6,870	—	1,925	8,795	3,460	210	490	3,740
	New York	8,165	300	1,575	9,440	3,841	300	700	4,241
	Syracuse	[c] 8,270	—	2,100	10,370	3,021	180	525	3,366
N.C:	Charlotte	[c] 17,045	—	1,400	18,445	5,752	330	700	6,122
N.D:	Minot	14,330	450	2,800	16,680	4,756	210	665	5,211
Ohio:	Cincinnati	[c] 14,765	—	1,925	16,690	4,367	300	420	4,487
	Cleveland	[c] 8,400	—	1,225	9,625	3,326	240	560	3,646
Okla:	Oklahoma City	[c] 23,625	—	1,225	24,850	4,663	180	630	5,113
Ore:	Portland	[c] 21,075	—	875	21,950	4,582	240	385	4,727
Pa:	Philadelphia	[c] 7,885	—	1,225	9,110	3,589	180	595	4,004
	Pittsburgh	[c] 9,270	—	1,575	10,845	4,376	300	665	4,741
P.R:	San Juan	[c] 23,200	—	700	23,900	3,000	150	350	3,200
R.I:	Providence	[c] 8,860	—	1,400	11,260	3,739	300	490	3,929
S.C:	Charleston	20,475	150	875	21,200	5,694	360	700	6,034
S.D:	Rapid City[f]	[c] 13,555	—	1,925	15,480	3,592	—	490	4,082
Tenn:	Chattanooga	[c] 36,855	—	1,400	38,255	6,802	360	665	7,107
	Memphis	[c] 34,530	—	1,400	35,930	6,468	420	700	6,748
Tex:	Austin	9,285	80	350	9,555	2,133	90	175	2,218
	Dallas	22,195	150	875	22,920	4,326	150	420	4,596
Utah:	Salt Lake City	9,155	300	1,225	10,080	2,492	150	350	2,692
Vt:	Burlington	[c] 7,300	—	2,275	9,575	3,287	180	595	3,702
Va:	Norfolk	[c] 17,335	—	1,225	18,560	5,037	300	735	5,472
Wash:	Seattle	17,410	750	1,575	18,235	4,492	330	630	4,792
	Spokane	[c] 9,505	—	1,050	10,555	3,389	180	420	3,629
W. Va:	Charleston	[c] 18,780	—	1,750	20,530	5,180	360	735	5,555
Wis:	Milwaukee	[e] 6,270	—	1,400	7,670	2,583	150	280	2,713
Wyo:	Laramie	[c] 11,525	—	3,325	14,850	2,766	210	455	3,011

[a] The data in this table are index values, not to be interpreted as consumption or total intake values. Annual strontium-89 or strontium-90 intake per person may be calculated from an index value in this table by applying the appropriate factor representing average daily milk consumption for any selected group under consideration.

Example: 12-month index value (μμc day/liter) × milk consumption factor (liter/day/person) = 12-month intake (μμc/person)

[b] Station began operation in October 1961. [c] Index value is for 11 months; no data available for September 1961. [d] Dash indicates no data are available. [e] Station began operation in July 1962. [f] Station began operation in January 1962.

SECTION IV.—WATER

Radioactivity in Raw Surface Waters

NATIONAL WATER QUALITY NETWORK
July 1962

Division of Water Supply and Pollution Control, Public Health Service

The National Water Quality Network was initiated in October 1957 (*1*). This network, operated by the Public Health Service in cooperation with State and local agencies, consisted of 120 stations as of the end of July (figure 1). These stations are located on the major waterways used for public water supplies, propagation of fish and wildlife, and recreational, agricultural, and industrial purposes. Samples are taken weekly, monthly, or continuously, depending on the type of analysis and the water quality. These samples are analyzed for plankton population, organic chemicals, chemical, biological, and physical quality, and radioactivity (*2*, *3*).

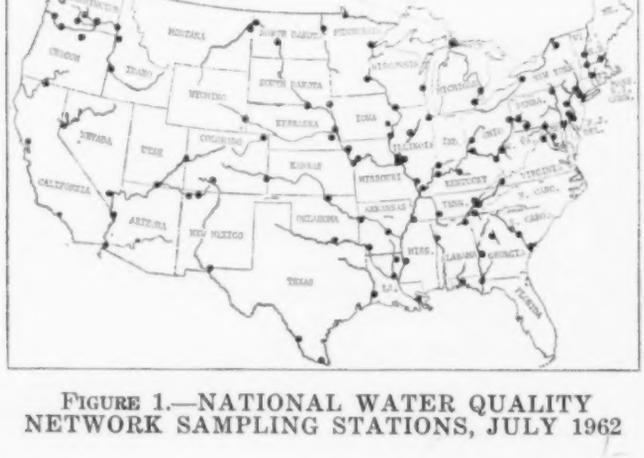


FIGURE 1.—NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS, JULY 1962

The radioactivity associated with dissolved solids provides a rough measure of the levels which may be found in treated water, since nearly all of the suspended matter is removed by treatment processes (*4*). It has been observed that in water the natural environmental beta activity is usually several times that of the natural environmental alpha activity. Nuclear installations may contribute additional alpha or beta activity whereas fallout contributes primarily additional beta activity. Gross alpha and beta measurements are made on both suspended and dissolved solids (strontium–90 on the total solids only) in raw surface water samples according to established procedures (*5*, *6*). Because strontium–90 analyses are done quarterly, the results will be published on this basis.

For the first two years, beta determinations were made on weekly samples and alpha determinations were generally made on composites of more than one weekly sample. From January 1960 to September 1961, alpha and beta determinations were generally made once a month

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS

[Average concentrations in pc/liter]

Station	July 1962					
	Beta activity			Alpha activity		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Allegheny River: Pittsburgh, Pa	0	12	12	—	—	—
Animas River: Cedar Hill, N. Mex	2	13	15	0	2	2
Apalachicola River: Chattahoochie, Fla	3	12	15	—	—	—
Arkansas River:						
Coolidge, Kansas	22	97	119	3	40	43
Ponca City, Okla	45	68	113	—	—	—
Pendleton Ferry, Ark	—	—	—	—	—	—
Bighorn River: Hardin, Mont	108	45	153	11	3	14
Big Sioux River: Sioux Falls, So. Dak	23	55	78	—	—	—
Chattahoochie River:						
Atlanta, Ga	7	10	17	0	0	0
Columbus, Ga	1	5	6	0	0	0
Lanett, Ala	2	4	6	0	0	0
Chena Slough: Fairbanks, Alaska	3	8	11	1	0	1
Clear Water River: East Lewiston, Idaho	—	—	—	—	—	—
Clinch River:						
Kingston, Tenn	65	205	270	0	0	0
Clinton, Tenn	2	7	9	0	0	0
Colorado River:						
Loma, Colo	15	33	48	2	1	3
Page, Ariz	—	—	—	—	—	—
Boulder City, Nev	0	38	38	0	3	3
Parker Dam, Calif. Ariz	6	12	18	0	8	8
Yuma, Ariz	37	17	54	5	2	7
Columbia River:						
Northport, Wash	4	12	16	0	<1	<1
Wenatchee, Wash	—	—	—	—	—	—
Pasco, Wash	9	116	125	0	0	0
McNary Dam, Ore	16	86	102	0	0	0
Bonneville, Ore	—	—	—	—	—	—
Clatskanie, Ore	—	—	—	—	—	—
Connecticut River:						
Wilder, Vt	2	15	17	0	0	0
Northfield, Mass	5	13	18	0	0	0
Enfield Dam, Conn	4	11	15	<1	0	<1
Cumberland River: Clarksville, Tenn	—	—	—	—	—	—
Delaware River:						
Martins Creek, Pa	3	12	15	0	0	0
Trenton, N. J	3	10	13	0	0	0
Philadelphia, Pa	4	22	26	—	—	—
Escambia River: Century, Fla	10	19	29	0	0	0
Great Lakes:						
Duluth, Minn	0	4	4	0	<1	<1
Sault Ste. Marie, Mich	3	8	11	—	—	—
Milwaukee, Wis	3	10	13	0	0	0
Gary, Ind	12	20	32	0	0	0
Port Huron, Mich	2	8	10	—	—	—
Detroit, Mich	1	8	9	0	0	0
Buffalo, N. Y	4	15	19	0	0	0
Hudson River: Poughkeepsie, N. Y	6	7	13	—	—	—
Illinois River:						
Peoria, Ill	6	37	43	1	0	1
Grafton, Ill	7	33	40	<1	2	3
Kanawha River: Winfield Dam, W. Va	—	—	—	—	—	—
Klamath River: Keno, Ore	4	12	16	0	0	0
Little Miami River: Cincinnati, Ohio	20	36	56	—	—	—
Mississippi River:						
St. Paul, Minn	20	52	72	—	—	—
Dubuque, Iowa	76	40	116	9	3	12
Burlington, Iowa	29	35	64	0	0	0
E. St. Louis, Ill	13	33	46	—	—	—
Cape Girardeau, Mo	41	35	76	47	1	48
W. Memphis, Ark	30	25	55	6	0	6
Delta, La	30	30	60	3	2	5
New Orleans, La	173	2	175	—	—	—
Vicksburg, Miss	20	20	40	2	<1	3
Missouri River:						
Williston, N. Dak	170	19	189	—	—	—
Bismarck, N. Dak	8	31	39	<1	1	2
Yankton, S. Dak	5	27	32	—	—	—
Omaha, Nebr	73	45	118	—	—	—
St. Joseph, Mo	114	46	160	1	0	1
Kansas City, Kans	16	21	37	1	0	1
St. Louis, Mo	138	6	144	—	—	—
Missouri City, Mo	35	20	55	15	4	19
Monongahela River: Pittsburgh, Pa	2	22	24	0	0	0
North Platte River: Henry, Nebr	84	80	164	4	14	18
Ohio River:						
Addison, Ohio	6	16	22	0	<1	<1
East Liverpool, Ohio	4	10	14	—	—	—
Huntington, W. Va	1	14	15	0	0	0
Cincinnati, Ohio	8	14	22	0	0	0
Louisville, Ky	—	—	—	—	—	—
Evansville, Ind	—	—	—	—	—	—
Cairo, Ill	2	24	26	0	1	1
Ouachita River: Bastrop, La	12	36	48	<1	0	<1
Pend Oreille River: Albeni Fall Dam, Idaho	7	11	18	0	0	0
Platte River: Plattsmouth, Nebr	63	59	122	5	5	10

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Continued

[Average concentrations in pc/liter]

Station	July 1962					
	Beta activity			Alpha activity		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Potomac River:						
Williamsport, Md	—	—	—	—	—	—
Great Falls, Md	2	7	9	—	—	—
Rainy River:						
Baudette, Minn	10	43	53	0	<1	<1
International Fls, Minn	—	—	—	—	—	—
Red River, North: Grand Forks, N. D	—	—	—	—	—	—
Red River, South:						
Denison, Tex	9	37	46	—	—	—
Index, Ark	—	—	—	—	—	—
Bossier City, La	25	41	66	1	1	2
Alexandria, La	9	26	35	5	2	7
Rio Grande River:						
Alamosa, Colo	62	26	88	0	0	0
El Paso, Tex	16	25	41	—	—	—
Laredo, Tex	381	34	415	0	1	1
Brownsville, Tex	16	46	62	0	2	2
Roanoke River: John H. Kerr Resr. & Dam, Va	13	13	26	1	0	1
Sabine River: Ruliff, Tex	10	14	24	0	0	0
Sacramento River: Greens Landing, Courtland, Calif	2	9	11	0	0	0
San Joaquin River: Vernalis, Calif	8	21	29	0	4	4
San Juan River: Shiprock, N. Mex	17	18	35	4	10	14
St. Lawrence River: Massena, N. Y	2	10	12	—	—	—
Schuylkill River: Philadelphia, Pa	6	13	19	0	0	0
Savannah River:						
North Augusta, S. C	9	7	16	0	0	0
Port Wentworth, Ga	7	28	35	0	0	0
Shenandoah River: Berryville, Va	—	—	—	—	—	—
Ship Creek: Anchorage, Alaska	3	10	13	1	0	1
Snake River:						
Payette, Idaho	4	27	31	—	—	—
Wawawai, Wash	4	10	14	0	0	0
South Platte River: Julesburg, Colo	71	58	129	19	28	47
Spokane River: Post Falls, Idaho	4	10	14	0	0	0
Susquehanna River:						
Sayre, Pa	4	11	15	—	—	—
Conowingo, Md	—	—	—	—	—	—
Tennessee River:						
Chattanooga, Tenn	—	—	—	—	—	—
Bridgeport, Ala	8	39	47	0	0	0
Pickwick Landing, Tenn	7	21	28	<1	0	<1
Tombigbee River: Columbus, Miss	28	18	46	2	<1	3
Truckee River: Farad, Calif	4	10	14	0	<1	<1
Verdigris River: Nowata, Okla	12	34	46	<1	0	<1
Wabash River: New Harmony, Ind	9	26	35	1	2	3
Yakima River: Richland, Wash	6	10	16	—	—	—
Yellowstone River: Sidney, Mont	21	2	23	—	—	—

on weekly composited samples. Beginning in September 1961, alpha determinations have been made on one sample each month, and beta determinations have generally been made on weekly samples. For the first operating year of each new station, sampling, and alpha and beta analysis are done weekly.

If at any time activity significantly greater than the normal environmental levels has been noted, the rate of sampling and analysis has been increased to at least one every week. Since January 1959, a portion of each sample from all stations in the network has been composited into a three-month station sample for measurement of strontium–90 (*7*).

REFERENCES

(*1*) National Water Quality Control Network, Public Health Service: *Fallout From Nuclear Weapons Tests*, *1*:167–9, Hearings before the Special Subcommittee on Radiation of the Joint Committee on Atomic Energy, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (May 1959), price $2.75.

(*2*) Division of Water Supply and Pollution Control, Public Health Service: *National Water Quality Network Annual Compilation of Data*, PHS Publication No. 663, 1960 Edition, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

(*3*) Setter, L. R., and S. L. Baker: Radioactivity of Surface Waters in the United States, *Radiological Health Data*, *1*:20–31 (October 1960).

(*4*) Straub, C. P.: Significance of Radioactivity Data, *Journal of the American Water Works Association*, *53*:704 (June 1961).

(*5*) Setter, L. R., J. E. Regnier, and E. A. Diephaus: Radioactivity of Surface Waters in the United States, *Journal of the American Water Works Association*, *51*:1377 (November 1959).

(*6*) Robert A. Taft Sanitary Engineering Center, Public Health Service: *Radionuclide Analysis of Environmental Samples*, Technical Report R59–6 (November 16, 1959).

(*7*) Straub, C. P., L. R. Setter, A. Goldin, and P. F. Hallbach: Strontium–90 in Surface Waters in the U.S., *Journal of the American Water Works Association*, *52*:756 (June 1960).

Radioactivity in Drinking Water, 1961

DRINKING WATER ANALYSIS PROGRAM

Division of Environmental Engineering and Food Protection, and
Division of Radiological Health, Public Health Service

The responsibility of the Public Health Service for the certification of drinking water supplies used by interstate common carriers has led to an extensive drinking water analysis program, initiated in November 1960. The analysis program, which is under the Service's Interstate Carrier Branch, is planned to ultimately cover the 850 U.S. water supplies serving interstate carriers.

Figure 1 shows the nationwide distribution of the 139 municipalities included in the first sampling, which was concluded in October 1961. In many instances, there are several sources for a municipality and each is sampled. A second sampling at these same cities is under way at present.

FIGURE 1.—DRINKING WATER ANALYSIS PROGRAM SAMPLING STATIONS

The drinking water standards for radionuclides (*1*) are conservative in their requirements so that the total intake of these nuclides from all sources is not likely to result in an intake greater than that recommended by the Federal Radiation Council (*2*). The standards provide for the approval of water supplies, based on their radionuclide content, when the water does not contain more than 3 μμc/liter of radium–226 or 10 μμc/liter of strontium–90. In the absence of strontium–90 (much less than 10 μμc/liter) and in the absence of alpha emitters (much less than 3 μμc/liter) the water supply is acceptable when the gross beta concentration does not exceed 1000 μμc/liter.

However, a water supply may be approved when the limits prescribed above are exceeded if it can be demonstrated by surveillance that the total intake of radioactivity from all sources is within the limits recommended by the Federal Radiation Council for control action. When mixtures of radionuclides are present, the proportion of each radionuclide to its maximum limit should be considered when evaluating the exposure.

The determinations performed on the selected carrier supplies are sanitary chemical analyses, carbon chloroform analyses, spectrographic examinations, certain quantitative chemical analyses, and radiochemical analyses. Each sample to be analyzed for radionuclides consists of a composite of three aliquots a day obtained over a two-week period. The analyses for gross alpha, gross beta, and strontium–90 are performed at the Southeastern, Northeastern, and Southwestern Radiological Health Laboratories, operated by the Division of Radiological Health.

Table 1 presents data from the 1961 sampling not previously published in *Radiological Health Data*. In table 2 the same data are arranged to facilitate rapid visual comprehension. Each item is shown in terms of its nationwide frequency distribution, range and mean. Also presented are the Drinking Water Standard limit, the total number of supplies which provide the data, and the number of "less than" (<) values. These data show that water from the majority of supplies contains radioactivity well below the acceptable limit.

Due to the limitation of analytical methods, it is often necessary to show a result as being "less than" a stated value. In statistically treating the data, the full "less than" value is used. The effect of this is to place an upper limit on the results which is quite satisfactory for surveillance and control action.

TABLE 1.—RADIOACTIVITY IN DRINKING WATERS (1961)

[Concentrations in μμc/liter]

Station location		Population served	Date sampled	Sr^{90}	Alpha activity			Beta activity		
City	State			Total solids	Suspended	Dissolved	Total[a]	Suspended	Dissolved	Total[a]
Birmingham	Ala.									
Shades Plant		600,000	10/ 4–10/18					<3.0	3.7	<6.7
Putnam Plant		—	10/ 4–10/18					<3.0	<3.0	<6.0
Gadsden	Ala.	600,000	9/25–10/10	1.8				<3.0	<3.4	<6.4
Tucson	Ariz.									
Sampling Point No. 1		223,000	5/ 1– 5/16							
Sampling Point No. 2		—	6/ 8– 6/21		<0.5	3.5	<4.0	<1.0	5.0	<6.0
Sampling Point No. 3		—	5/17– 6/ 1							
Winslow	Ariz.	9,000	5/16– 5/31							
Fresno	Calif.	150,000	10/ 2–10/18					2.3	3.5	5.8
Los Angeles	Calif.									
L.A. Rv. Conduit Sys		2,510	8/28– 9/12							
Lower Van Norman Res		—	7/ 6– 7/20							
Eagle Rock Res		—	7/26– 8/ 9							
Foot Hill Pump Sta		—	8/16– 8/30							
San Pedro Station		—	7/13– 7/27							
Mullholland Res		—	9/14– 9/28							
Martinez	Calif.	15,000	3/ 8– 3/22							
Sacramento	Calif.	181,000	3/ 1– 3/15							
Needles	Calif.	5,000	7/18– 8/ 4		<0.5	<0.5	<1.0	<1.0	8.2	<9.2
Hartford	Conn.	375,000	4/26– 5/10		<5.0	<5.0	<10.0	<3.0	<3.0	<6.0
Wilmington	Del.									
Porter Filter Plant		156,000	2/13– 3/ 1			<0.5			<2.6	
Brandywine Filter Plt		156,000	11/ 7–11/21					<3.0	7.2	<10.2
Washington	D.C.									
Dalecarlia Plant		1,100	10/11–10/26					<3.0	7.5	<10.5
McMillan Plant		1,100	10/11–10/28					<3.0	6.1	<9.1
Hilo	Hawaii	25,000	4/19– 5/ 4							
Burlington	Iowa	35,000	10/24–11/ 7						11.4	
Des Moines	Iowa	234,000	11/ 1–11/17						<2.6	
Lexington Main Plant	Ky.	125,000	1/23– 2/ 7			<0.5				
Alexandria	La.	50,000	8/ 8– 8/21					<3.0	<3.0	<6.0
Baton Rouge	La.	200,000	8/ 9– 8/31					<3.0	<3.0	<6.0
New Orleans	La.	600,000	8/10– 8/24					<3.0	3.9	<6.9
Hagerstown	Md.									
Potomac River Station		—	10/ 9–10/25					<3.0	6.0	<9.0
Bay City	Mich.	70,000	9/14– 9/29					<3.0	4.4	<7.4
Muskegon	Mich.	62,000	9/12– 9/27					<3.0	7.6	<10.6
Sault Ste. Marie	Mich.	20,000	9/13– 9/29					<3.0	5.4	<8.4
Cape Girardeau	Mo.	25,000	1/ 3– 1/17							
St. Louis	Mo.									
Howard Bend Plant		250,000	12/ 5–12/19/60							
Chain of Rocks Plant		250,000	3/27– 4/10							
Grand Forks	N. Dak.	34,000	11/ 9–12/ 1		1.1	6.4	7.5	0.8	12.5	13.3
Lincoln	Nebr.	129,000	10/24–11/ 8					1.2	18.6	19.8
Omaha	Nebr.	400,000	2/13– 2/27							
Reno	Nev.	50,000								
Berlin	N. H.	17,000	5/ 1– 5/13		<0.5	<0.5	<1.0	<3.0	<1.0	<4.0
Manchester	N. H.	92,000	5/ 3– 5/17		<0.5	<0.5	<1.0	<3.0	4.4	<7.4
Trenton	N. J.	200,000	10/ 2–10/16					<3.0	10.0	<13.0
Albuquerque	N. Mex.	214,000	6/ 6– 6/21		<0.5	2.2	<2.7	<1.0	4.8	<5.8
Farmington	N. Mex.	24,000	6/ 7– 7/ 3							
New York City	N. Y.									
Jamaica, W.S. Co.		600,000	10/16–11/ 3					<3.0	3.4	<6.4
Woodhaven Water Co.		150,000	10/30–11/14					<3.0	3.2	<6.2
Poughkeepsie	N. Y.	40,000	9/12– 9/26					<3.0	3.4	<6.4
Rochester										
Lake Hemlock Source		250,000	9/13– 9/27	3.3				<3.0	3.7	<6.7
Lake Ontario Source		42,000	9/13– 9/26					<3.0	5.4	<8.4
Monroe Co. Water Auth		30,000	9/14– 9/27	<1.0				<3.0	4.6	<7.6
Schenectady	N. Y.	112,000	9/28–10/10						<3.0	
Troy	N. Y.	73,000	9/27–10/12					<3.0	<3.0	<6.0
Cincinnati	Ohio	750,000	3/13– 3/29		<0.5	<0.5	<1.0	<3.0	<3.0	<6.0
Lima	Ohio	58,000	3/16– 3/30		<0.5	<0.5	<1.0	<3.0	4.6	<7.6
Springfield	Ohio	90,000	3/15– 3/30		<0.5	<0.5	<1.0	<3.0	<3.0	<6.0
Oklahoma City	Okla.									
Lake Hefner		310,000	2/ 9– 2/25	1.2		6.0			5.7	
Lake Overholser		310,000	5/25– 6/ 8		<0.5	<0.5	<1.0	<3.0	6.2	<9.2
Eugene	Ore.	62,000	10/24–11/ 9						1.4	
Allentown	Pa.	112,000	6/ 1– 6/15		<0.5	<0.5	<1.0	<3.0	<3.0	<6.0
Philadelphia	Pa.									
Torresdale Plant		1,000,000	1/30– 2/14			<0.5			<2.6	
Providence	R. I.	383,000	3/27– 4/10						<3.0	
Brownwood	Tex.	18,000	4/24– 5/ 9	<1.0	<0.5	<0.5	<1.0	<3.0	7.0	<10.0
Corpus Christi	Tex.									
Cunningham Plant		198,000	3/28– 4/13		<0.5	<0.5	<1.0	<3.0	5.6	<8.6
Stephens Plant		—	4/ 5– 4/19	<1.0	<0.5	<0.5	<1.0	<3.0	6.2	<9.2
Galveston	Tex.	71,000	7/18– 8/ 3					<3.0	<3.0	<6.0
Laredo	Tex.	118,000	4/26– 5/25		<0.5	<0.5	<1.0	<3.0	4.3	<7.3
Lubbock	Tex.	128,000	2/28– 3/16		<0.5	<0.5	<1.0	<3.0	12.8	<15.8
Port Arthur	Tex.	90,000	7/19– 8/ 2					<3.0	3.5	<6.5
San Angelo	Tex.	60,000	4/25– 5/ 9		<0.5	<0.5	<1.0	<3.0	<3.0	<6.0
San Antonio	Tex.	517,000	2/21– 3/10		<0.5	<0.5	<1.0	<3.0	<3.0	<6.0
Waco	Tex.	100,000	5/25– 6/ 9		<0.5	<0.5	<1.0	<3.0	3.5	<6.5
Wichita Falls	Tex.	101,000	5/26– 6/10		<0.5	<0.5	<1.0	<3.0	3.5	<6.5

TABLE 1.—RADIOACTIVITY IN DRINKING WATERS (1961)—Continued

[Concentrations in μμc/liter]

Station location		Population served	Date sampled	Sr^{90}	Alpha activity			Beta activity		
City	State			Total solids	Suspended	Dissolved	Total[a]	Suspended	Dissolved	Total[a]
Portsmouth	Va.	—	8/21- 9/ 7					35.0	10.0	45.0
Richmond	Va.	—	12/ 6-12/21					<3.0	10.0	<13.0
Burlington	Vt.	45,000	1/11- 1/25	1.9	<0.5	<0.5	<1.0	<2.6	2.9	<5.5
Bellingham	Wash.									
Lake Whatcomb		39,000	2/ 7- 2/21							
Lake Padden		—	2/22- 3/ 8							
Longview	Wash.	32,000	1/17- 1/31							
Pasco	Wash.	14,000	6/ 5- 6/19							
Spokane	Wash.	182,000	7/26- 8/10		<0.5	<0.5	<1.0	2.3	5.7	8.0

[a] Where "less than" values comprise more than 10 percent of the total, the "less than" sign (<) is shown with the total.

TABLE 2.—ACTIVITY IN DISSOLVED SOLIDS OF INTERSTATE CARRIERS WATER SUPPLIES (1961)

Strontium-90 activity		Beta activity		Alpha activity	
Range from 0.1 to 3.3 μμc/liter Drinking water standards limit—10 μμc/liter Arithmetic mean—1.0 μμc/liter Total number of supplies—27 Number of "less than" values—8		Range from 0.6 to 300.0 μμc/liter Drinking water standards limit—1000 μμc/liter Arithmetic mean—7.2 μμc/liter Total number of supplies—141 Number of "less than" values—56		Range from 0.5 to 19.9 μμc/liter Drinking water standards limit—none except for Ra^{226} (3 μμc/liter) Arithmetic mean—1.5 μμc/liter Total number of supplies—80 Number of "less than" values—70	
Interval (pc/liter)	No. of supplies	Interval (pc/liter)	No. of supplies	Interval (pc/liter)	No. of supplies
0.0–0.2	4	0.0– 1.9	4	0.0–0.1	0
0.3–0.5	4	2.0– 2.9	16	0.2–0.3	0
0.6–0.8	4	3.0– 3.9	67	0.4–0.5	69
0.9–1.1	10	4.0– 4.9	12	>0.5	11
1.2–1.4	1	5.0– 5.9	10		
1.5–1.7	0	6.0– 6.9	11		
1.8–2.0	2	7.0– 7.9	4		
2.1–2.3	0	8.0– 8.9	1		
2.4–2.6	0	9.0– 9.9	1		
2.7–2.9	0	10.0–10.9	3		
>2.9	2	11.0–11.9	2		
		12.0–12.9	3		
		13.0–13.9	1		
		14.0–14.9	1		
		15.0–15.9	1		
		>15.9	4		

REFERENCES

(1) Federal Register Rules and Regulations: *Title 42 Public Health Chapter 1, Public Health Service,* Department of Health, Education, and Welfare; Part 72, *Interstate Quarantine, Subpart J, Drinking Water Standards,* pp. 2154–5, (March 6, 1962).

(2) Federal Radiation Council: *Background Material for the Development of Radiation Protection Standards, Report No. 2,* Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (September 1961), price 20 cents.

Previous coverage in *Radiological Health Data:*

Period	Issue
1960 and 1961	*May 1962*
1960 and 1961	*August 1962*
1960 and 1961	*October 1962*

RADIOSTRONTIUM IN TAP WATER[1]
March–June 1962

Health and Safety Laboratory
U.S. Atomic Energy Commission

The Health and Safety Laboratory has performed analyses for strontium–90 concentrations in tap water at New York City since August 1954 and at Richmond, California since April 1958. Each sample analyzed is a monthly composite of daily samples. Also, determinations for strontium–89 have been made since September 1961.

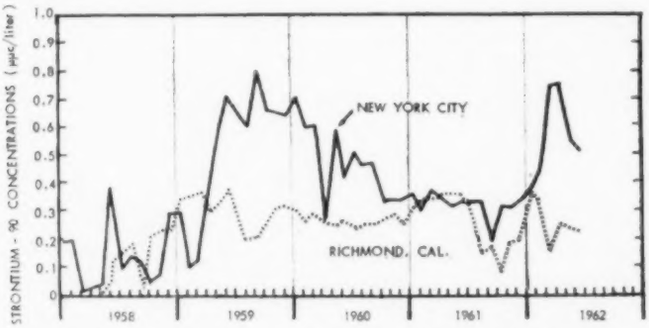


FIGURE 2.—STRONTIUM–90 CONCENTRATIONS IN TAP WATER

Data for the past several years are plotted in figure 1. Data prior to 1958 appear in an earlier HASL report.[2] Strontium–90 concentrations and strontium–89/strontium–90 ratios for March through June 1962 appear in table 1.

TABLE 1.—RADIOSTRONTIUM IN TAP WATER

Month	New York City[a]		Richmond, California[b]	
	Sr^{90} (μμc/liter)	Sr^{89}/Sr^{90}[c]	Sr^{90} (μμc/liter)	Sr^{89}/Sr^{90}[c]
1959 Average	0.40		0.29	
1960 Average	0.47		0.26	
1961 Average	0.32		0.25	
1962 March	0.73	3.1	0.14	20.3
April	0.74	7.7	0.25	9.2
May	0.54	4.0	0.23	4.2
June	0.51	3.8	0.22	4.6

[a]From 100–200 liters per sample.
[b]Approximately 100 liters per sample.
[c]Strontium–89 extrapolated to midpoint of sampling period.

The strontium–90 concentrations for New York City reached their peak during March and April 1962 and are now declining. Although Richmond did not report as high strontium–90 concentrations as New York City, the higher strontium–89/strontium–90 ratios in Richmond during January through April 1962 indicate that the fallout was of more recent origin there.

Previous coverage in *Radiological Health Data:*

Period	Issue
First quarter 1961	*December 1961*
Second quarter 1961	*March 1962*
Third and fourth quarters 1961	*June 1962*
January–April 1962	*September 1962*

[1] U.S. Atomic Energy Commission: *Fallout Program Quarterly Summary Report, HASL–127,* Office of Technical Services, Department of Commerce, Washington 25, D.C. (July 1, 1962), price $3.00.

[2] U.S. Atomic Energy Commission: *Environmental Contamination from Weapons Tests, HASL–42,* Office of Technical Services, Department of Commerce, Washington 25, D.C. (October 1962), price $3.50.

SECTION V.—OTHER DATA

Summary of State Dental Radiological Health Activities

James W. Miller[1]

Concern over the possible hazards from ionizing radiation has caused an increasing awareness by the dental profession of its role in the exposure of the population to X-rays. With this awareness, dental societies have in some cases requested, and in all instances cooperated in, public health programs designed to evaluate the problem and to reduce or eliminate unnecessary radiation exposure from dental sources.

Of the estimated 200,000 X-ray machines in use in this country, approximately 100,000 are owned and operated by dentists. These dentist-operated machines expose about 185,000,000 dental films a year. While the contribution to population exposure doses arising from dental radiography is considerably less than that from medical sources (*1*, *2*), the conservative assumption is that the somatic and genetic effects resulting from radiation insult have no threshold and that a direct linear relationship exists between dose and biological effect (*3*). Thus, in general, any exposure of ionizing radiation to an individual or population group is potentially hazardous, and the benefits resulting from an exposure of X-rays must be weighed by the risk involved. No matter how small the present radiation exposure is to the patient or to the occupationally exposed person, if it can be reduced, every reasonable effort should be made to reduce this exposure.

Studies conducted in larger centers of population by interested parties and agencies following the 1956 report of the National Academy of Sciences (*4*) indicated that a large percentage of the dental X-ray machines in this country did not meet recommendations set forth by the National Committee on Radiation Protection and Measurements (*5*) or the recommendations of the American Academy of Oral Roentgenology (*6*).

On the basis of these findings, dental radiological health programs were established in many State health departments.

Survey of Dental Radiological Health

The types of dental radiological health programs that have been or are being conducted nationally by health departments were ascertained by a Public Health Service survey[2] of each of the fifty States, the District of Columbia and Puerto Rico. Inquiries were made about their activities and accomplishments in dental radiological health. The information requested

[1] Dr. Miller is Project Officer, Dental Radiological Health Project, State Assistance Branch, Division of Radiological Health, Public Health Service.

[2] Conducted by Division of Radiological Health, Public Health Service. The data under discussion are valid as of December 1, 1962.

pertained primarily to the areas of legislation, regulations, inspection, correction, and education. Information was obtained from all fifty States, the District of Columbia and Puerto Rico.

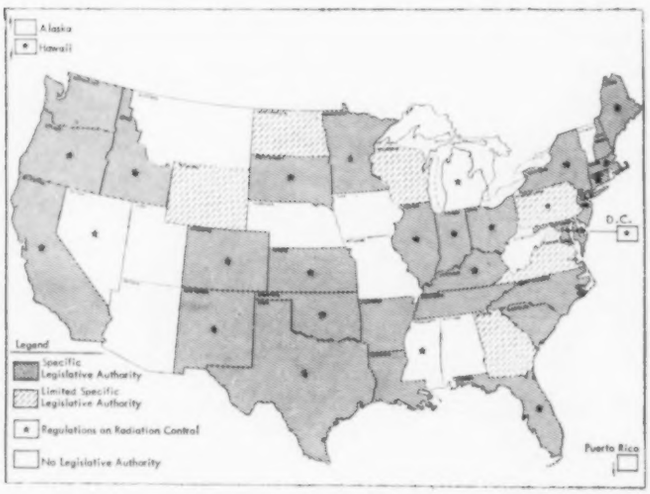


FIGURE 1.—STATES WITH RADIATION CONTROL ACTIVITIES, AS OF DECEMBER 1, 1962

Thirty-six States and the District of Columbia have enacted some type of specific legislation for radiation control activities. The bulk of the legislative action for radiation control has taken place within the past three years. Four other States have adopted radiation control regulations under the broad authority of the department of health. Thus, a total of forty States and the District of Columbia have adopted some form of control of radiation sources. About two-thirds of the population in the United States live in these States. Figure 1 shows those States with radiation control activities. The scope of the radiation codes or regulations vary with the State. Some have only industrial codes which do not apply to the licensed art of healing. Codes which include the licensed practitioners of the healing arts do not ordinarily limit the amount of radiation that may intentionally be applied to a person for diagnostic purposes by or under the direction of a dentist. Only ten States have specific requirements for dental X-ray machines and installations. Requirements for dental X-ray installations in these States usually parallel closely the recommendations of the National Committee on Radiation Protection and Measurements (*5*).

Twenty-seven States and the District of Columbia, shown in figure 2, require registration of dental X-ray machines. Approximately 70 percent of the dental X-ray machines in this country are located in these States. Estimates on the probable number of X-ray machines located in a State are based on an average of 1.03 X-ray machines per dentist. This figure has been determined by previous dental X-ray surveys in various parts of the country, although the actual number in a given State may vary from this. The number of dentists in each State is based on figures from the American Dental Association (*7*). A total of 29,228 dental X-ray machines have been registered in seventeen States reporting numbers registered to date.

FIGURE 2.—STATES REQUIRING REGISTRATION OF DENTAL X-RAY MACHINES, AS OF DECEMBER 1, 1962

Inspection programs of dental X-ray equipment and/or installations have been or are now being conducted in forty-nine States. Two survey techniques for the inspection of dental X-ray equipment are generally used. One method of conducting a large scale survey of dental X-ray machines, to determine whether machines have characteristics leading to unnecessary radiation, is the "by mail" Dental Surpak procedure.[3] It is designed to check the size of the beam at the end of the pointer cone, the approximate roentgen output, total filtration (inherent and added), beam symmetry, and leakage radiation in the direction of a

[3] A description of the Surpak may be found on page 46 of this issue.

patient's face. While this procedure assists materially in indicating the need for reducing unnecessary patient and occupational exposure, it does not completely remove the need for installation inspections. The Surpak does serve, however, as an aid in surveying rural and inaccessible areas, locating priority needs, and as a method of follow-up after recommended improvements reportedly have been made.

The other method of conducting a survey of dental X-ray machines is the physical inspection of the dental office. The physical survey usually covers equipment, technique, and occupational exposure. The technique of inspection will depend on the established objectives of the X-ray program.

TABLE 1.—TYPE OF PROGRAM CONDUCTED

Type of Inspection	Number of States[1]
Installation visit only	17
Surpak only	9
Combination of Surpak and other[2]	24
Other only	1
TOTAL	51

[1] District of Columbia and Puerto Rico counted as States.
[2] Other includes film badge and template.

Of the forty-nine States that have conducted some type of inspection program, seventeen conduct installation visits only, nine have used the Surpak only, and twenty-four plus the District of Columbia and Puerto Rico have or are using a combination of the Surpak with some other method, usually an installation inspection. These data are presented graphically in figure 3 and tabularly in table 1. The estimated number of X-ray inspections conducted by State or local health departments, as shown in table 2, is set at 67,300. While some of these inspections may have been duplications of different inspection methods on the same dental X-ray machine, 67,300 inspections represent a substantial number. These figures do not include studies such as the one reported by Yale (*8*) or inspections performed by private companies or individuals. Of the thirty States that have used the Surpak in their program, eighteen have completed their initial survey, in the sense that 65 to 95 percent of the dentists

TABLE 2.—NUMBER OF DENTAL X-RAY INSPECTIONS

Type of Inspection	Number of States	Estimated Number of Inspections
Installation visit	37	26,000
Surpak	30	28,000
Other*	6	3,300
		67,300

* Other includes film badges and template.

cooperated on a voluntary basis. The mode is 80 percent voluntary cooperation on a national basis. Figure 3 shows States with inspection programs.

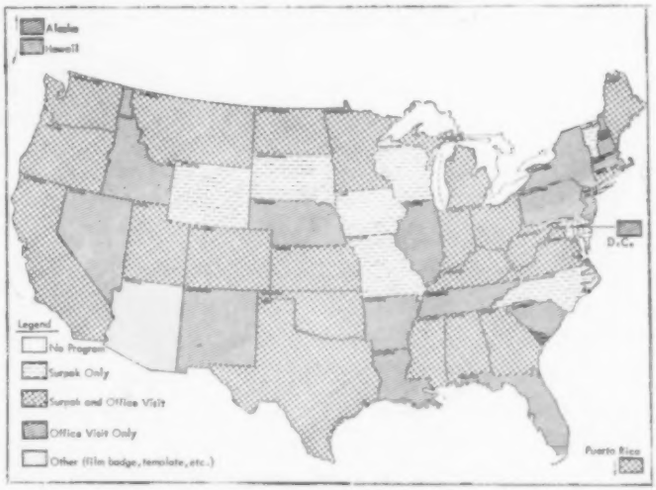


FIGURE 3.—STATES CONDUCTING DENTAL INSPECTION PROGRAMS, AS OF DECEMBER 1, 1962

One State health department, Nevada's, has completed an office visit inspection of every dental X-ray installation within the State. This program was conducted on a voluntary basis. One hundred percent participation is possible with the complete cooperation and support of the State and local dental societies. Three or four other health departments have completed inspections of nearly 100 percent of the dental offices within their States. Dental X-ray installation inspection programs are well underway in many other States.

Although information was sought on the type of correction program for filtration and collimation that is being conducted, this phase of the dental radiological health program has

not been actively underway for a sufficient length of time to properly evaluate the number corrected. Experience of the Division of Radiological Health and other investigators indicate that 40 to 75 percent of the X-ray units inspected required additional collimation and filtration to meet recommended standards. The type of correction program and the number of States involved is presented in table 3.

TABLE 3.—FILTRATION AND COLLIMATION CORRECTION PROGRAMS

Type of Program	Number of States*
None	8
Sent to dentist only	2
Installed when inspected only	9
Recommend only	10
Combination of above types	17
	TOTAL 51

*District of Columbia and Puerto Rico counted as States.

Most State dental radiological health programs are conducted in cooperation with other disciplines of the health departments. Only seven States reported that their programs were conducted strictly by the dental section. In fourteen States the dental radiological health activities have been carried on by other disciplines in the health department without the assistance of the dental program. Only one State reported no activity in the dental radiological health area.

TABLE 4.—EDUCATIONAL PROGRAMS CONDUCTED

Response	Number of States
No	10
Yes	34
Planned	5
No Response	3
	TOTAL 52*

*Includes District of Columbia and Puerto Rico.

Table 4 shows the number of States conducting educational programs. It is generally agreed that a certain degree of educational effort is necessary to attain the objective of a program. This is especially true in the area of dental radiological health, where most State programs have been on a voluntary, cooperative basis with the dental profession.

The educational programs being conducted or planned were divided into several categories as presented in table 5. The effectiveness of these educational efforts is difficult to evaluate. One method of evaluation might be the number of dental X-ray machines found in need of filtration or collimation. Based on such a method, educational efforts to date have not been effective, since 40 to 75 percent of the dental X-ray machines inspected still do not meet present-day standards for filtration and collimation.

TABLE 5.—TYPE OF EDUCATIONAL PROGRAM CONDUCTED OR PLANNED

Type	Number of States
A. None	5
B. Not stated	11
C. Education at time of inspection	2
D. Pamphlet only	3
E. Pamphlet plus educational inspection	4
F. Publications in state journal or newsletter	4
G. Combination of talks & film at society meetings plus articles in State journals	13
H. Combination of C & G	7
I. Post-graduate instruction	3
	52*

*Includes District of Columbia and Puerto Rico.

In an attempt to evaluate the dental radiological health programs, information was requested on the planned scope of the States' programs. From the replies received, the scope of the programs was separated into four categories as presented in table 6. From this breakdown, it appears that most of the States have plans for a continuing program of inspection and correction.

Assistance to State Programs From the Public Health Service

Support that States need to carry out their dental radiological health programs is being provided by the Public Health Service's Divi-

TABLE 6.—PLANNED SCOPE OF STATE PROGRAM

Scope	Number of States
No answer	5
Inspection only	5
Inspection plus correction	15
Periodic inspection and correction	10
Continuous program of inspection, correction, and education	17
	TOTAL 52*

*Includes District of Columbia and Puerto Rico.

sion of Radiological Health. Dental personnel from this Division have consulted with and/or assisted in some manner virtually every State health department in this country. Additionally, each of the nine Regional Offices of the Public Health Service is staffed with a program director for radiological health. The program directors are available to individual States for technical consultation and assistance in developing radiological health programs. Also, professional staff members are on loan to State health departments. Some of these personnel have been used in dental X-ray inspection programs.

Thirty-five States have received or are scheduled to receive Surpaks before June 1963. Many other States have expressed an interest in this method of conducting large-scale surveys of dental X-ray machines. A total of 52,000 Surpaks have been requested by State health departments. Up to December 1, 1962, 33 States had received 40,000 of the scheduled Surpaks.

With regard to educational aids, the Public Health Service booklet "Radiation Protection for Dentist and Patient,"* is typical of the type of material being used effectively in these State programs.

Diagnostic X-ray survey kits loaned by the Public Health Service are being used by the States in carrying on their X-ray inspection programs. Filters and collimators to bring the five most common dental X-ray machines found in this country up to recommended standards are also being furnished by the Public Health Service at no charge to the States. Thirty-two States have requested that collimators and filters be made available to them. To date, enough filters and collimators have been sent to State health departments to correct 43,000 dental X-ray machines.

Summary

1. A survey was made of State dental radiological health programs.
2. Thirty-six States have enacted some type of specific legislation for radiation control activities.
3. Twenty-eight States reported that they required registration of dental X-ray machines.
4. Inspection programs of dental X-ray equipment and/or installations have been or are now being conducted in forty-nine States. The estimated number of X-ray machine inspections conducted by State or local health departments is placed at 67,300.

REFERENCES

(1) Lindell, B., and L. R. Dobson: *Ionizing Radiation and Health, World Health Organization Public Health Paper, No. 6*, Geneva (1961).

(2) Committee on Radiological Hazards to Patients: *Radiological Hazards to Patients—Second Report of the Committee*, Her Majesty's Stationery Office, London (1960), price six shillings.

(3) Federal Radiation Council: *Background Material For the Development of Radiation Protection Standards, Report No. 1*, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (May 13, 1960), price 30 cents.

(4) National Academy of Sciences-National Research Council: *The Biological Effects of Atomic Radiation, Summary Reports*, Washington, D.C. (1956).

(5) National Committee on Radiation Protection and Measurements: *Medical X-Ray Protection Up to Three Million Volts, National Bureau of Standards Handbook 76*, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (February 9, 1961), price 35 cents.

(6) Richards, A. G., et al.: X-Ray Protection in the Dental Office, *Journal of the American Dental Association, 56*:514–21 (April 1958).

(7) Bureau of Economic Research and Statistics, American Dental Association: Changes in the Distribution of Dentists, 1956–1960, *Journal of the American Dental Association, 63*:715–20 (November 1961).

(8) Yale, S. H.: A Ten State Study of the Status of Radiation Hygiene in the Dental Office, *Journal of the American Dental Association, 63*:201–10 (August 1961).

* Public Health Service: *Radiation Protection for Dentist and Patient*, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (May 1962), price 15 cents.

The Dental Surpak Survey Method

Division of Radiological Health, Public Health Service

Of the several methods of conducting large scale radiation surveys of dental X-ray machines which are available to public health agencies, the Surpak is a simplified approach whereby the practicing dentist participates with his health agency in determining whether his X-ray unit has characteristics which contribute to unnecessary radiation exposure.

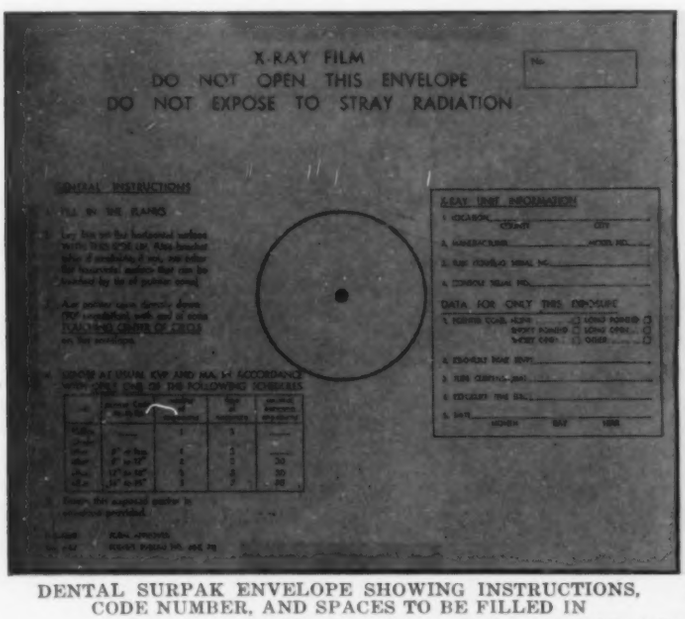
The procedure is useful primarily in assessing factors which affect X-ray exposures of dental patients. However, since many of the factors which affect patient X-ray doses are related in part to the radiation exposures in the immediate vicinity of the machine, the procedure may provide a clue to the occupational doses of the dentist and his assistant. While this method assists materially in indicating the need for reducing unnecessary patient and occupational exposure, it will not completely remove the need for a physical inspection. In addition, it can serve as an aid in surveying rural and inaccessible areas, locating priority needs, and as a method of follow-up and evaluation after recommended improvements reportedly have been made.

The complete Surpak consists of three parts:

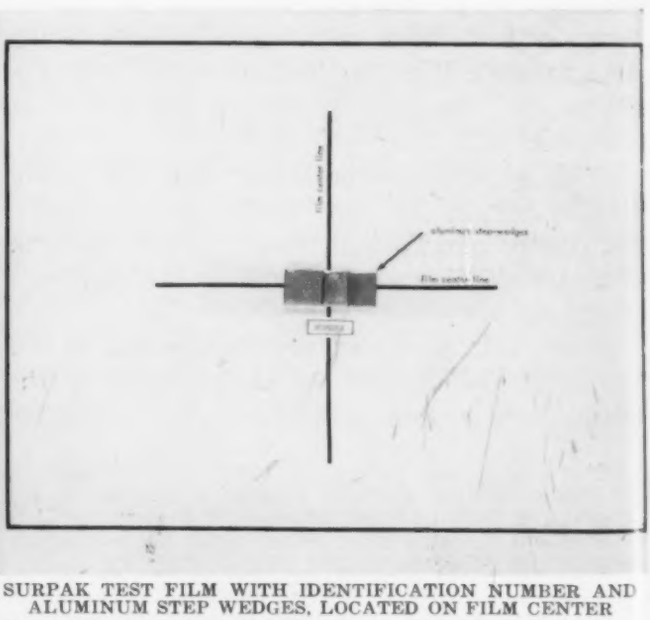
1. A mailing envelope. This envelope has the health agency's address imprinted in the upper left-hand corner.
2. A return-mail envelope. This envelope has the health agency's address imprinted in the center of the face of the envelope.
3. The Surpak itself in a sealed envelope. On the face of this envelope will be found a code number, general instructions, and spaces to be filled in by the dentist in reference to his particular X-ray machine(s) (see figure 1).

The general instructions direct the dentist to lay the film envelope on a flat horizontal surface with the face up, aim the pointer cone directly down on the Surpak with the end of the cone touching the center of the circle on the envelope, expose according to one of the printed schedules on the envelope, and return in the envelope provided. The spaces to be filled in are labeled location (county and city), manufacturer, model number, tube housing serial number, console serial number, and data for this exposure (pointer cone used, kilovolt peak, tube current, exposure time, and date).

The name and address of the dentist appears nowhere on any Surpak. The sealed Surpak envelope contains a lead backing and an 8″ x 10″ slow industrial-type X-ray film on which

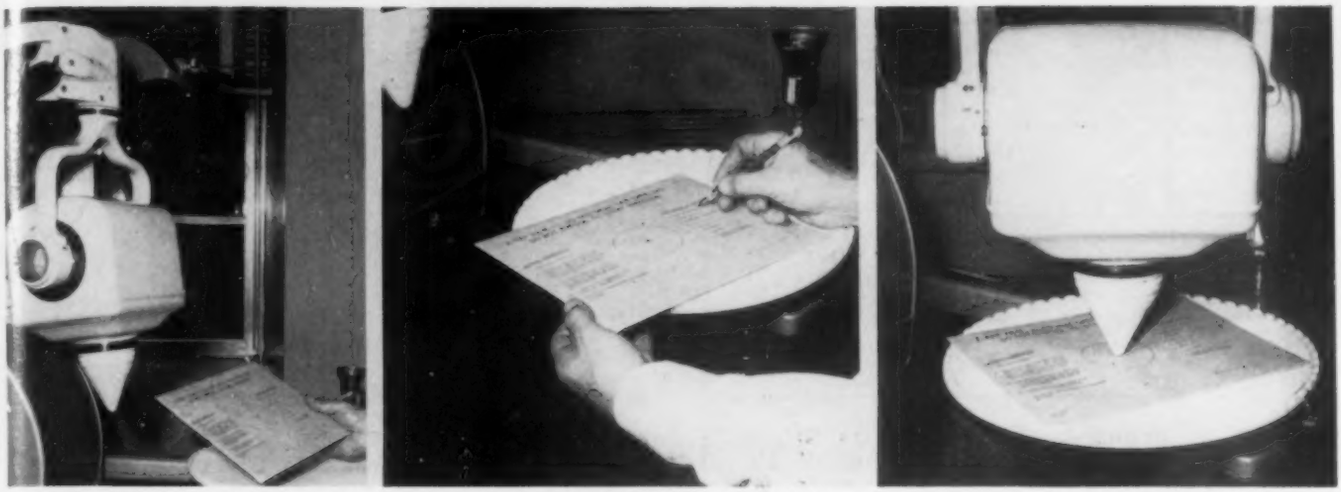


DENTAL SURPAK ENVELOPE SHOWING INSTRUCTIONS, CODE NUMBER, AND SPACES TO BE FILLED IN



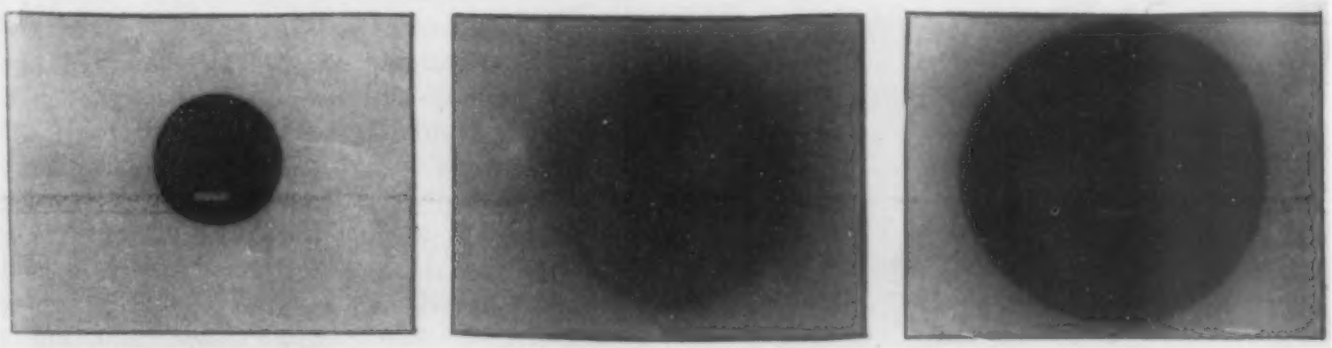
SURPAK TEST FILM WITH IDENTIFICATION NUMBER AND ALUMINUM STEP WEDGES, LOCATED ON FILM CENTER

FIGURE 1.—THE DENTAL SURPAK KIT AS MAILED TO PARTICIPATING DENTISTS



REVIEWING THE INSTRUCTIONS | SUPPLYING EXPOSURE INFORMATION | EXPOSING THE FILM

FIGURE 2.—RECOMMENDED PROCEDURE FOR USING THE DENTAL SURPAK



ACCEPTABLE (DIAMETER 3 INCHES OR LESS) | UNACCEPTABLE (DIAMETER GREATER THAN 3 INCHES) | EXTREME

FIGURE 3.—EXAMPLES OF BEAM SIZES OBSERVED DURING THE SURPAK SURVEY

is mounted an aluminum step-wedge and a lead code number (see figure 1). The health agency assigns a code number to each participating dentist and mails a complete Surpak to him. The dentist, in turn, fills in the blanks, exposes the Surpak as instructed, and returns it by mail to the health department (see figure 2). This takes just a few moments of his time. The exposed Surpaks are then returned by the health agency to the Public Health Service Radiological Health Laboratory, Rockville, Maryland, for controlled processing and interpretation.*

The Surpak, when properly used, can provide information for a specific X-ray machine about the size of the beam at the end of the pointer cone, the approximate roentgen output in mr/mas, total filtration (inherent and added), beam symmetry, and leakage radiation in the direction of a patient's face.

The beam size can be gaged from the exposed film. Figure 3 shows acceptable (3 inches or less), unacceptable (more than 3 inches), and extreme beam sizes. The extreme beam size is an example of a machine with little or no collimation. The roentgen output and total filtration can be determined from the exposed film with the step-wedges and the information supplied by the participating dentist. The exposed film will also reveal the beam symmetry and leakage radiation in the direction of the patient. Figure 4 shows examples of poor symmetry and good symmetry, while figure 5 shows an example of leakage radiation.

Information obtained from the processed film is then transferred to data processing punch cards from which a list of findings is prepared,

* Information on obtaining Surpaks or filters and collimators may be obtained from the Division of Radiological Health, Public Health Service.

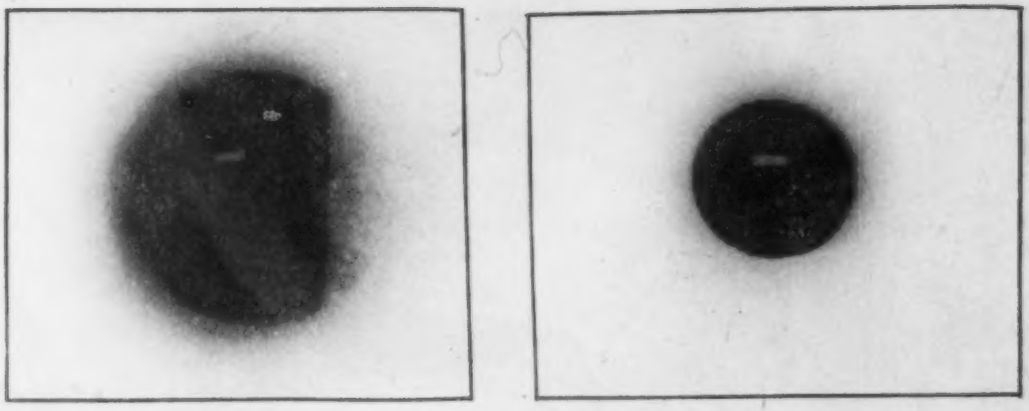


FIGURE 4.—EXAMPLES OF BEAM SYMMETRY: FILM AT LEFT SHOWS POOR BEAM SYMMETRY; FILM AT RIGHT SHOWS GOOD BEAM SYMMETRY

and forwarded back to the local health departments. Each health department in turn notifies the participating dentists of the results obtained and makes recommendations as to whether or not their X-ray machines require corrective procedures to bring them up to recommended standards.

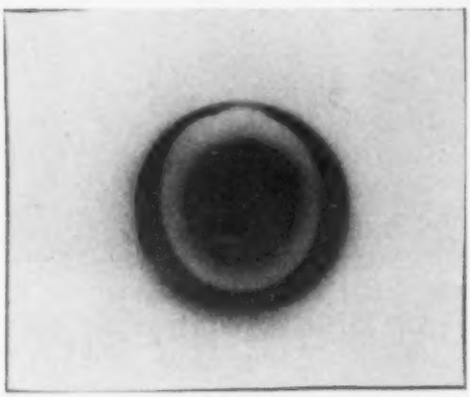
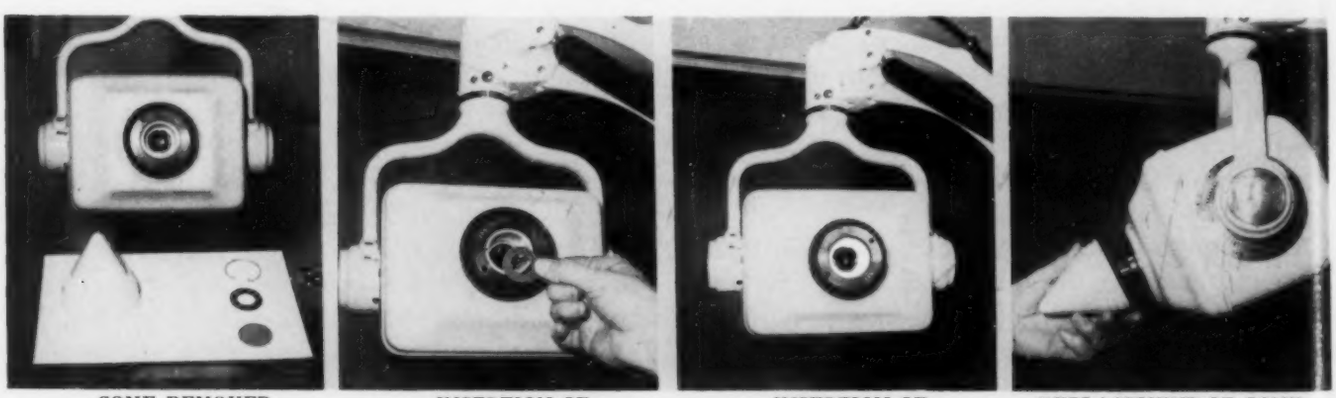


FIGURE 5.—FILM SHOWING EVIDENCE OF LEAKAGE RADIATION AS CONCENTRIC SHADOW AROUND BEAM IMAGE

Partial results from the survey of the 40,000 Surpaks distributed to 33 States indicate that as of November 1962, 40–75 percent of the dental X-ray machines inspected do not meet present-day standards. Of this number, approximately 95 percent can be brought up to approved standards by the insertion of the proper lead collimator and the correct thickness of aluminum filter. Figure 6 illustrates a typical installation of the collimator and filters. As can be seen, this is a relatively simple and easy procedure. With the insertion of the proper collimator and filters, appreciable reduction of unnecessary radiation exposure of the population from dental X-ray machines may be achieved. Two-fold to 100–fold reductions in the radiation exposure of certain tissues of patients' faces may be achieved.

Many State health departments have established standards for dental X-ray machines. In general, these standards include a 2.75—3–inch beam diameter at the tip of the pointer cone and a 1.5—2 mm aluminum equivalent of total



CONE REMOVED | INSERTION OF LEAD WASHER | INSERTION OF ALUMINUM DISK | REPLACEMENT OF CONE

FIGURE 6.—TYPICAL INSTALLATION OF A FILTER AND COLLIMATOR

filtration for equipment operating up to 70 kvp, or 2.5 mm aluminum equivalent of total filtration for units capable of operating above 70 kvp. These standards are based upon recommendations of the National Committee on Radiation Protection and Measurements (*1*) and the American Academy of Oral Roentgenology (*2*).

REFERENCES

(*1*) National Committee on Radiation Protection and Measurements: *Medical X-ray Protection Up to Three Million Volts, National Bureau of Standards Handbook 76*, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (February 9, 1961), price $0.25.

(*2*) Richards, A. G., et al.: X-Ray Protection in the Dental Office, *Journal of the American Dental Association, 56*:514–21 (April 1958).

Volume of X-Ray Visits[1]

July 1960–June 1961

U.S. National Health Survey, Public Health Service

In order to determine the average X-ray dose in the United States, the number of X-ray visits for various population groups becomes an important factor in dose calculations. Recognizing the importance of medical and dental X-ray exposures in the total radiation dosage to the average person, the U.S. National Health Survey, starting in July 1960, undertook a 12–month household interview survey of medical and dental X-ray visits. The results of the survey are based on estimates of 85,303,000 visits for medical treatment or diagnosis by X-ray and on 49,768,000 dental X-ray visits in a national sample (from July 1960 through June 1961) survey.

I. Limitations of Data

Some limitations of the data should be briefly mentioned in this abstract. The data were obtained from a probability sample of approximately 38,000 households, and are subject to sampling errors. No attempt was made to obtain the number of exposures; therefore, the term "X-ray visit" may include more than one exposure for fluoroscopy, film exposure, or therapy. Visits for radioisotope treatment were not included in the scope of the survey. The data were tabulated by six general areas (chest, lower abdomen, upper abdomen, extremities, head and neck, and skin). This was done because of the inability of some respondents to report specific bones, organs, or types of X-ray procedure. An overall limiting factor, as in all interviews, is the difficulty which respondents have in recalling events over a long span of time. The extent of this bias was reduced by using a 3–month recall period. The average annual volume of visits was received from the 3–month reference period data.

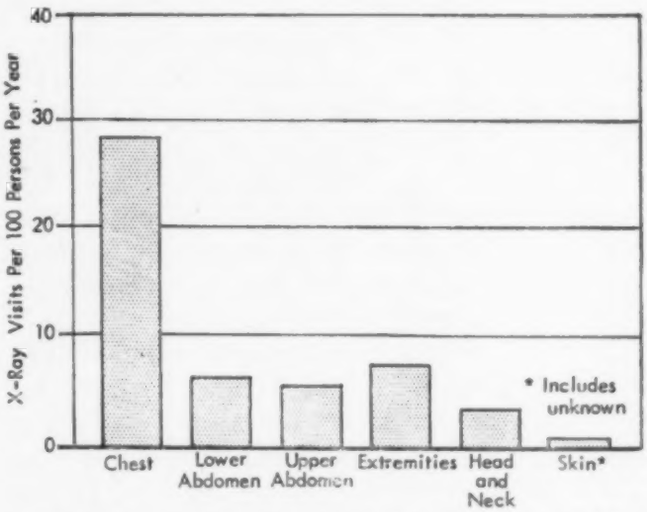


FIGURE 1.—DISTRIBUTION OF BODY AREAS X-RAYED, JULY 1960–JUNE 1961

*II. Results and Discussion**

A. *Medical X-Ray Visits*

1. *Area of Body X-Rayed*: Figure 1 shows the distribution of body areas X-rayed. The data are also represented in table 1. In general, there was little difference between men and women in volume and rate of X-rays of all areas of the body. However, men, especially those in the 45–64 age group, were somewhat higher in volume and rate of chest X-rays. X-

[1] Summarized from *Health Statistics—Volume of X-Ray Visits, July 1960–June 1961*, Public Health Service Publication No. 584–B38, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (October 1962), price 40 cents.

* *Editor's note: Data on socio-economic factors were also collected by the U.S. National Health Survey, but are not presented herein.*

TABLE 1.—AREA OF BODY X-RAYED DURING VISIT, JULY 1960—JUNE 1961

Sex and age	All medical X-ray visits [1]	Area of body X-rayed					
		Chest	Lower abdomen	Upper abdomen	Extremities	Head and neck	Skin [2]
Both sexes	Number of medical X-ray visits in thousands						
All ages	85,303	51,084	11,119	9,969	13,610	5,972	1,0 0
Under 15	9,403	3,912	818	378	3,399	1,298	*
15–29	19,418	12,576	1,752	1,637	3,225	1,117	*
30–44	22,044	14,013	2,584	2,828	2,674	1,384	*
45+	34,439	20,582	5,966	5,126	4,312	2,172	*
45–64	25,852	15,461	4,090	3,909	3,191	1,632	*
65+	8,587	5,121	1,876	1,217	1,121	540	*
Male							
All ages	43,063	25,868	4,897	4,494	7,581	2,879	497
Under 15	5,308	2,115	(*)	(*)	2,072	805	*
15–29	9,463	5,802	766	585	2,285	424	*
30–44	10,891	6,963	1,153	1,293	1,519	555	*
45+	17,401	10,987	2,656	2,443	1,704	1,094	*
45–64	13,345	8,299	2,010	1,870	1,386	825	*
65+	4,057	2,688	646	574	(*)	(*)	*
Female							
All ages	42,240	25,216	6,222	5,475	6,028	3,092	502
Under 15	4,095	1,797	496	(*)	1,326	493	*
15–29	9,954	6,774	986	1,052	940	692	*
30–44	11,153	7,050	1,431	1,535	1,154	829	*
45+	17,037	9,595	3,310	2,683	2,607	1,078	*
45–64	12,507	7,161	2,080	2,040	1,806	807	*
65+	4,530	2,434	1,229	643	802	(*)	*
Both sexes	Number of medical X-ray visits per 100 persons per year						
All ages	47.9	28.7	6.2	5.6	7.6	3.4	0.6
Under 15	16.4	6.8	1.4	0.7	5.9	2.3	*
15–29	57.1	37.0	5.2	4.8	9.5	3.3	*
30–44	63.0	40.0	7.4	8.1	7.6	4.0	*
45+	66.5	39.7	11.5	9.9	8.3	4.2	*
45–64	71.2	42.6	11.3	10.8	8.8	4.5	*
65+	55.4	33.0	12.1	7.8	7.2	3.5	*
Male							
All ages	49.7	29.9	5.7	5.2	8.8	3.3	0.6
Under 15	18.2	7.3	(*)	(*)	7.1	2.8	*
15–29	58.4	35.8	4.7	3.6	14.1	2.6	*
30–44	64.9	41.5	6.9	7.7	9.1	3.3	*
45+	71.2	45.0	10.9	10.0	7.0	4.5	*
45–64	76.3	47.5	11.5	10.7	7.9	4.7	*
65+	58.4	38.7	9.3	8.3	(*)	(*)	*
Female							
All ages	46.2	27.6	6.8	6.0	6.6	3.4	0.5
Under 15	14.6	6.4	1.8	(*)	4.7	1.8	*
15–29	55.9	38.0	5.5	5.9	5.3	3.9	*
30–44	61.2	38.7	7.9	8.4	6.3	4.5	*
45+	62.3	35.1	12.1	9.8	9.5	3.9	*
45–64	66.5	38.1	11.1	10.8	9.6	4.3	*
65+	53.0	28.5	14.4	7.5	9.4	(*)	*

[1] The sum of visits by area of body X-rayed may be greater than the total number of visits, since during one visit more than one area of body may be X-rayed.
[2] Skin includes an estimated 39,000 unknown areas X-rayed.
* Magnitude of the sampling error precludes showing separate estimates.

rays of this area of the body were most frequent in women of the 30–44 age group.

There was a notable difference by age groups of males and females making visits for X-rays of the extremities. Among males the highest rate was found in the 15–29 age group. This has been ascribed as probably due to the high injury rate of males of this age.

A greater number of women than men received X-rays of the lower and upper abdomen and the rate of women making visits for X-rays of the lower abdomen was even greater than visits for X-rays of the extremities. This difference is undoubtedly due to the greater necessity of pelvic examinations for women.

There was little difference between the sexes in the number and frequency of exposures of the head and neck area, and of the skin area.

2. *Place of X-Ray*: Not tabulated in this summary, but included in the original report, are data on the place of X-ray. The majority of X-rays of every area of the body were re-

eived on visits to a hospital. Outside of hospitals, chest X-rays were most often made in places other than a doctor's office—probably in mobile X-ray units and industrial medical facilities. Only 4.8 percent of X-rays of abdomen and extremities and a negligible amount of head and neck and skin X-rays were given in places other than a hospital or doctor's office.

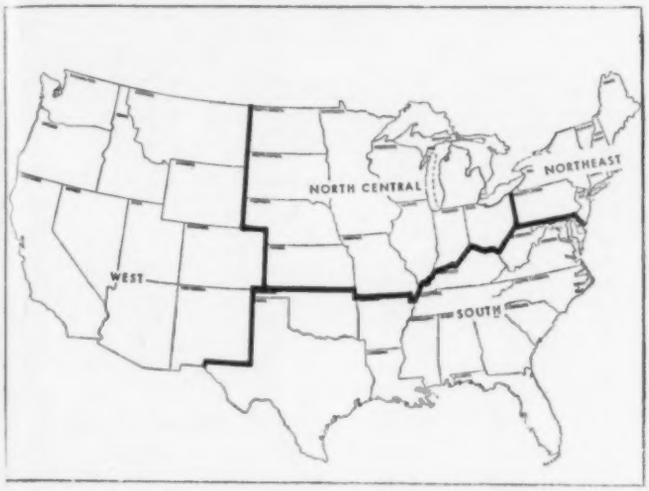


FIGURE 2.—REGIONS OF THE COUNTRY (AFTER BUREAU OF THE CENSUS)—WEST INCLUDES ALASKA AND HAWAII

3. *Regional Distribution*: The survey also included a breakdown into regional groups of persons making X-ray visits. The regions used are those of the Bureau of the Census, as shown in figure 2. Table 2 shows that the largest number of visits were made by men of the North Central section of the country and by women from the South. North Central area women and Southern men were next in number of visits. Both sexes of the Northeast and West were next and last, respectively, in number of visits.

The rate of visits, however, was highest for those in the West. Next highest rate was for North Central males and Southern females and then for Southern males and North Central females. Residents of the Northeast region reported the lowest rate of medical X-ray visits.

In general, both men and women of ages 45–64 had the highest rate of medical X-ray visits in each of the four regions of the country. The only exception was a high rate of visits among males aged 15–29 in the Western region.

4. *Residential Distribution*: The National Health Survey also revealed differences in number of X-ray visits according to residence, as demonstrated in table 3. Volume of visits was highest for men and women living inside urbanized areas. Rural nonfarm residents and then residents of "other urban places" were the groups next in number of visits. The number of visits by rural farm residents was very much lower than the number of visits made by residents of other areas.

In terms of rate of visits, residents inside urbanized areas were again ahead of other groups. Second in number of visits, rural nonfarm women were also next highest in rate of visits. However, "other urban" male residents were second highest in rate of visits, while only third highest in number of visits. Male and female rural farm dwellers remained much lower in rate as well as volume of visits for medical X-ray.

For the most part, men and women in the 45 years and up age group were highest in number and rate of visits. An exception was the rate for rural farm males, where the 30–44 age group made visits most frequently. Among rural nonfarm women, the 30–44 age group was highest in both rate and volume of visits.

B. *Dental X-Ray Visits*

1. *Regional Distribution*: Table 4 shows the regional distribution of dental X-ray visits. Males under 15 and females aged 15–29 from the Northeast were highest in number of dental X-ray visits. Males under 15 from the West and females aged 15–29 from the North Central region were the second largest groupings. Next in number of visits were North Central males under 15 and Western females aged 15–29. Southerners of each sex made the fewest visits.

In terms of rate of visits there was little difference by sex among the regions. Western men and women most frequently made such visits. Next were Northeastern and then North Central residents. Southerners had the lowest rate as well as lowest number of visits. In most instances, it was the 15–29 age group that had the highest rate. Exceptions were the high rates of 30–44–year–old North Central males and 30–44–year–old Southerners of each sex.

2. *Residential Distribution*: When grouped according to residence, those who live within urbanized areas were shown to be highest in number and rate of dental X-ray visits. In all

TABLE 2.—REGIONAL DISTRIBUTION OF MEDICAL X-RAY VISITS, JULY 1960—JUNE 1961

Sex and age	Region				
	All regions	Northeast	North Central	South	West
Both sexes	Number of medical X-ray visits in thousands				
All ages	85,303	20,514	23,544	25,170	16,076
Under 15	9,403	2,178	2,400	2,806	2,018
15–29	19,418	4,316	5,208	5,883	4,011
30–44	22,044	5,236	6,180	6,440	4,189
45+	34,439	8,784	9,756	10,040	5,859
45–64	25,852	6,567	7,505	7,386	4,395
65+	8,587	2,217	2,251	2,654	1,465
Male					
All ages	43,063	10,399	12,389	12,265	8,011
Under 15	5,308	1,388	1,361	1,519	1,040
15–29	9,463	1,856	2,708	2,720	2,179
30–44	10,891	2,636	3,198	3,052	2,005
45+	17,401	4,518	5,122	4,973	2,787
45–64	13,345	3,442	3,947	3,726	2,230
65+	4,057	1,077	1,175	1,248	557
Female					
All ages	42,240	10,115	11,155	12,905	8,065
Under 15	4,095	791	1,040	1,287	978
15–29	9,954	2,459	2,500	3,163	1,831
30–44	11,153	2,600	2,982	3,388	2,184
45+	17,037	4,266	4,633	5,067	3,072
45–64	12,507	3,125	3,557	3,660	2,164
65+	4,530	1,140	1,076	1,407	907
Both sexes	Number of medical X-ray visits per 100 persons per year				
All ages	47.9	44.3	47.3	46.4	57.9
Under 15	16.4	15.8	15.0	15.5	21.8
15–29	57.1	51.3	55.9	53.7	75.5
30–44	63.0	53.4	64.5	64.1	75.3
45+	66.5	61.4	65.9	66.7	76.6
45–64	71.2	66.1	74.4	68.6	79.6
65+	55.4	50.8	47.6	61.9	68.7
Male					
All ages	49.7	46.7	50.3	46.8	59.6
Under 15	18.2	19.7	16.5	16.5	22.4
15–29	58.4	46.7	59.2	52.3	88.9
30–44	64.9	56.7	67.5	64.6	75.3
45+	71.2	68.5	72.3	70.5	75.3
45–64	76.3	73.5	80.3	72.4	81.3
65+	58.4	56.2	54.2	65.3	58.1
Female					
All ages	46.2	42.2	44.4	46.1	56.3
Under 15	14.6	11.8	13.3	14.4	21.3
15–29	55.9	55.3	52.8	54.9	63.9
30–44	61.2	50.5	61.5	63.6	75.2
45+	62.3	55.4	60.0	63.4	77.8
45–64	66.5	59.5	68.8	65.2	78.0
65+	53.0	46.6	42.0	59.2	77.3

* Magnitude of the sampling error precludes showing separate estimates.

areas, the 15–29 age group was generally highest in number and rate for both males and females.

Among urban residents, the number of visits was highest in the under 15 age group for males, and in the 15–29 age group for females, while the rate for both sexes was highest in the 15–29 age group.

Among rural residents, the number of visits was highest in the under 15 age group for males, and in the 30–44 age group for females. The rate of visits was highest in the 30–44 age group for males and in the 15–29 age group for females.

III. *Statistical Design*

A multistage probability design was utilized for this study. A sample of 500 was drawn from the 1900 geographically-defined Primary Sampling Units (county, group of contiguous counties, or a standard Metropolitan Statistical Area) of the United States. Within each Primary Sampling Unit are geographically-defined segments containing six households. Each

TABLE 3.—RESIDENTIAL DISTRIBUTION OF MEDICAL X-RAY VISITS, JULY 1960—JUNE 1961

Sex and age	Residence					
	All areas	Urban			Rural nonfarm	Rural farm
		Total	Inside urbanized areas	Other urban places		
Both sexes	Number of medical X-ray visits in thousands					
All ages	85,303	56,593	43,322	13,271	22,190	6,520
Under 15	9,403	5,459	4,137	1,322	3,340	604
15–29	19,418	13,269	9,960	3,308	4,698	1,451
30–44	22,044	13,747	10,574	3,173	6,776	1,521
45+	34,439	24,119	18,651	5,468	7,377	2,943
45–64	25,852	18,103	14,087	4,017	5,501	2,248
65+	8,587	6,016	4,565	1,451	1,876	696
Male						
All ages	43,063	28,472	21,772	6,699	11,062	3,530
Under 15	5,308	3,241	2,491	750	1,777	(*)
15–29	9,463	6,283	4,535	1,747	2,291	890
30–44	10,891	6,850	5,380	1,471	3,184	857
45+	17,401	12,098	9,367	2,731	3,810	1,494
45–64	13,345	9,401	7,453	1,948	2,931	1,013
65+	4,057	2,697	1,914	783	879	481
Female						
All ages	42,240	28,122	21,549	6,572	11,128	2,990
Under 15	4,095	2,218	1,646	572	1,563	(*)
15–29	9,954	6,986	5,425	1,561	2,407	561
30–44	11,153	6,897	5,194	1,703	3,592	665
45+	17,037	12,021	9,284	2,737	3,566	1,450
45–64	12,507	8,703	6,633	2,069	2,570	1,235
65+	4,530	3,319	2,651	668	997	(*)
Both sexes	Number of medical X-ray visits per 100 persons per year					
All ages	47.9	53.0	56.0	45.0	44.2	31.1
Under 15	16.4	17.1	18.2	14.5	18.4	8.4
15–29	57.1	63.9	67.2	55.6	50.3	37.3
30–44	63.0	65.7	67.6	60.0	63.9	43.8
45+	66.5	72.4	77.1	60.0	61.1	45.8
45–64	71.2	78.0	81.9	66.8	64.2	49.9
65+	55.4	59.6	65.3	46.9	53.7	36.2
Male						
All ages	49.7	55.9	59.1	47.5	44.7	32.3
Under 15	18.2	20.1	21.7	16.0	19.3	(*)
15–29	58.4	64.1	64.9	62.0	52.6	43.8
30–44	64.9	69.3	72.8	58.9	61.3	50.4
45+	71.2	80.2	85.4	66.5	63.9	44.0
45–64	76.3	87.1	93.1	70.0	67.5	42.9
65+	58.4	62.8	64.5	59.0	54.1	46.5
Female						
All ages	46.2	50.3	53.1	42.8	43.8	29.7
Under 15	14.6	14.2	14.6	12.9	17.5	(*)
15–29	55.9	63.7	69.2	49.9	48.3	30.2
30–44	61.2	62.5	62.9	61.1	66.4	37.5
45+	62.3	66.0	70.2	54.7	58.5	47.7
45–64	66.5	70.0	72.1	64.0	60.8	57.4
65+	53.0	57.3	65.8	37.8	53.3	(*)

* Magnitude of the sampling error precludes showing separate estimates.

week about 120 segments were drawn at random and all household members in each segment were then interviewed.

The design mentioned above allows for pooling of data from week to week into larger samples. Continuous measurement, as well as detailed analysis, was achieved.

By the end of the twelve-month period, approximately 125,000 persons in 38,000 households of 6400 segments were included in the sample. The data were collected by the Bureau of the Census and analyzed by the National Health Survey. The statistics produced were applied to the 1950 decennial population and to age and sex classes for estimation purposes.

Other adjustments were made for nonresponse, type of question asked, measurement error, and rounding off. Further detail is afforded this and other aspects of the survey in the original report.

TABLE 4.—REGIONAL DISTRIBUTION OF DENTAL X-RAY VISITS, JULY 1960—JUNE 1961

Sex and age	Region				
	All regions	Northeast	North Central	South	West
Both sexes	Number of dental X-ray visits in thousands				
All ages	48,768	15,141	11,915	10,241	11,4 1
Under 15	12,230	3,493	2,875	2,399	3,4 3
15–29	13,881	4,453	3,603	2,727	3,0 7
30–44	12,351	3,919	2,989	2,611	2,8 2
45+	10,305	3,276	2,448	2,503	2,0 8
45–64	8,686	2,766	2,103	2,044	1,7 4
65+	1,619	511	(*)	459	(*)
Male					
All ages	20,661	6,481	5,000	4,172	5,0 9
Under 15	5,978	1,810	1,433	1,053	1,6 1
15–29	5,086	1,557	1,269	1,046	1,2 3
30–44	5,149	1,605	1,375	1,004	1,1 5
45+	4,449	1,508	923	1,069	9 9
45–64	3,717	1,279	752	851	8 6
65+	731	(*)	(*)	(*)	(*)
Female					
All ages	28,106	8,661	6,915	6,069	6,4 2
Under 15	6,253	1,682	1,442	1,346	1,782
15–29	8,795	2,896	2,334	1,681	1,884
30–44	7,202	2,314	1,614	1,607	1,667
45+	5,857	1,768	1,525	1,434	1,129
45–64	4,969	1,486	1,351	1,193	938
65+	888	(*)	(*)	(*)	(*)
Both sexes	Number of dental X-ray visits per 100 persons per year				
All ages	27.4	32.7	24.0	18.9	41.3
Under 15	21.4	25.4	17.9	13.2	37.5
15–29	40.8	52.9	38.7	24.9	58.3
30–44	35.3	40.0	31.2	26.0	50.9
45+	19.9	22.9	16.5	16.6	27.2
45–64	23.9	27.8	20.9	19.0	32.1
65+	10.4	11.7	(*)	10.7	(*)
Male					
All ages	23.9	29.1	20.3	15.9	37.2
Under 15	20.5	25.6	17.4	11.4	36.3
15–29	31.4	39.2	27.7	20.1	49.5
30–44	30.7	34.5	29.0	21.3	43.8
45+	18.2	22.9	13.0	15.1	25.6
45–64	21.3	27.3	15.3	16.5	30.5
65+	10.5	(*)	(*)	(*)	(*)
Female					
All ages	30.7	36.1	27.5	21.7	45.1
Under 15	22.3	25.1	18.5	15.1	38.7
15–29	49.4	65.2	49.3	29.2	65.8
30–44	39.5	44.9	33.3	30.2	57.4
45+	21.4	23.0	19.7	17.9	28.6
45–64	26.4	28.3	26.1	21.2	33.8
65+	10.4	(*)	(*)	(*)	(*)

* Magnitude of the sampling error precludes showing separate estimates.

TABLE 5.—RESIDENTIAL DISTRIBUTION OF DENTAL X-RAY VISITS, JULY 1960—JUNE 1961

Sex and age	Residence				
	All areas	Urban			Rural
		Total	Inside urbanized areas	Other urban places	
Both sexes	Number of dental X-ray visits in thousands				
All ages	48,768	33,379	26,776	6,603	15,389
Under 15	12,230	7,794	6,275	1,519	4,436
15–29	13,881	10,028	7,808	2,220	3,854
30–44	12,351	7,961	6,532	1,429	4,390
45+	10,305	7,597	6,161	1,435	2,709
45–64	8,686	6,318	5,169	1,149	2,368
65+	1,619	1,279	993	(*)	(*)
Male					
All ages	20,661	14,029	11,132	2,898	6,632
Under 15	5,978	3,824	3,112	712	2,153
15–29	5,086	3,725	2,720	1,006	1,361
30–44	5,149	3,312	2,701	612	1,837
45+	4,449	3,167	2,599	568	1,281
45–64	3,717	2,666	2,190	476	1,051
65+	731	501	409	(*)	(*)
Female					
All ages	28,106	19,350	15,645	3,705	8,756
Under 15	6,253	3,970	3,163	807	2,283
15–29	8,795	6,302	5,088	1,214	2,493
30–44	7,202	4,649	3,831	818	2,553
45+	5,857	4,429	3,562	867	1,427
45–64	4,969	3,652	2,979	673	1,317
65+	888	777	584	(*)	(*)
Both sexes	Number of dental X-ray visits per 100 persons per year				
All ages	27.4	31.2	34.6	22.4	21.6
Under 15	21.4	24.5	27.6	16.6	17.5
15–29	40.8	48.3	52.7	37.3	29.1
30–44	35.3	38.1	41.8	27.0	31.2
45+	19.9	22.8	25.5	15.7	14.6
45–64	23.9	27.2	30.0	19.1	18.1
65+	10.4	12.7	14.2	(*)	(*)
Male					
All ages	23.9	27.5	30.2	20.5	18.6
Under 15	20.5	23.7	27.1	15.2	16.6
15–29	31.4	38.0	38.9	35.7	21.3
30–44	30.7	33.5	36.6	24.5	26.7
45+	18.2	21.0	23.7	13.8	13.7
45–64	21.3	24.7	27.4	17.1	15.7
65+	10.5	11.7	13.8	(*)	(*)
Female					
All ages	30.7	34.6	38.6	24.1	24.7
Under 15	22.3	25.3	28.1	18.2	18.5
15–29	49.4	57.5	64.9	38.8	36.5
30–44	39.5	42.1	46.4	29.3	35.5
45+	21.4	24.3	26.9	17.3	15.6
45–64	26.4	29.4	32.4	20.8	20.6
65+	10.4	13.4	14.5	(*)	(*)

* Magnitude of the sampling error precludes showing separate estimates.

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Summaries of the environmental radioactivity data for 21 AEC installations have appeared periodically in *Radiological Health Data* since November 1960. Summaries follow for Brookhaven National Laboratory and Rocky Flats Plant.

The measured concentration of a radionuclide in air and water may be compared with the Maximum Permissible Concentration (MPC) of that nuclide as recommended by the National Committee on Radiation Protection and Measurement (NCRP). For the environment near an AEC installation, the applicable MPC's are one-tenth of the occupational MPC values for continuous exposure given in the National Bureau of Standards "Handbook 69." The MPC values applicable to the following reports are given in table 1.

In the following reports, the use of nonspecific terms such as "total activity," "total alpha," and "gross beta" do not in themselves suggest any one MPC value. Often, when concentrations are low, a laboratory will assign an MPC value that is more restrictive than necessary. This avoids the more costly isotopic tests necessary to justify a less restrictive value. References to table 1 will be made to designate the appropriate MPC's reported by the laboratories.

BROOKHAVEN NATIONAL LABORATORY
January–June 1962

Associated Universities, Inc.
Upton, New York

The Brookhaven National Laboratory (BNL) operations may affect the environmental levels of radiation in two ways: (1) by discharge of

TABLE 1.—SELECTED ENVIRONMENTAL MPC VALUES PERTAINING TO AEC INSTALLATION REPORTS IN THIS SUBSECTION

Line no.	Radionuclide or mixture of unknown nuclides	Environmental MPC's	
		Water ($\mu\mu c$/liter)	Air ($\mu\mu c/m^3$)
1	If Sr^{90}, I^{129}, Pb^{210}, Po^{210}, At^{211}, Ra^{223}, Ra^{224}, Ra^{226}, Ac^{227}, Ra^{228}, Th^{230}, Pa^{231}, Th^{232}, and Th-nat are not present[a]	3,000	—
2	If Sr^{90}, Pb^{210}, Ra^{226}, Ra^{228} are not present[a]	600	—
3	If Ra^{226}, Ra^{228} are not present[a]	100	—
4	Mixture of unidentified nuclides	10	0.04
5	If α emitters and Ac^{227} are not present[a]	—	1.0
6	If α emitters and Pb^{210}, Ac^{227}, Ra^{228}, Pu^{241} are not present[a]	—	10
7	If α emitters and Sr^{90}, I^{129}, Pb^{210}, Ac^{227}, Ra^{228}, Pa^{230}, Pu^{241}, Bk^{249} are not present[a]	—	100
8	Argon–41 (immersion)	—	40,000
9	Plutonium–239	5,000	0.06
10	Uranium-natural	20,000	2

[a] "Not present" implies that the concentration of the nuclide is small compared with its appropriate MPC. According to recent AEC regulation (Federal Register, Title 10, Part 20, August 9, 1961), a group of nuclides may be considered not present if the ratio of each nuclide to its appropriate MPC is equal to or less than $\frac{1}{10}$ and if the sum of these ratios for the group in question is equal to or less than $\frac{1}{4}$.

coolant air from the graphite research reactor and (2) by the discharge of low level radioactive liquid wastes into a small stream that forms one of the headwaters of the Peconic River.

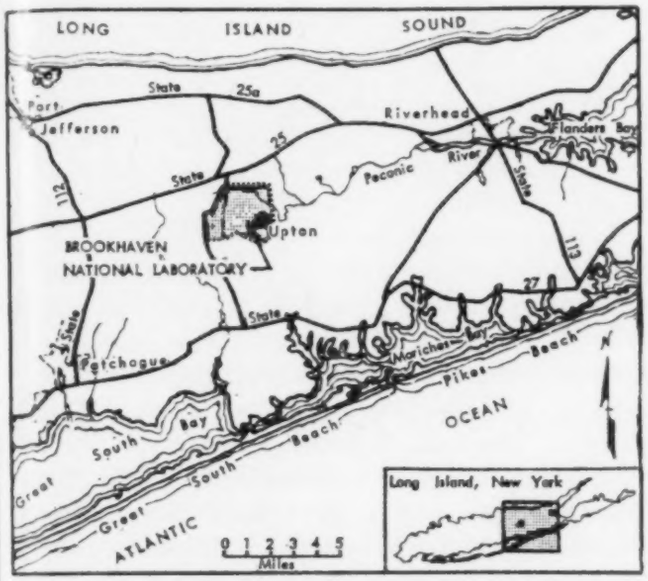


FIGURE 1.—BROOKHAVEN NATIONAL LABORATORY AND SURROUNDING AREA

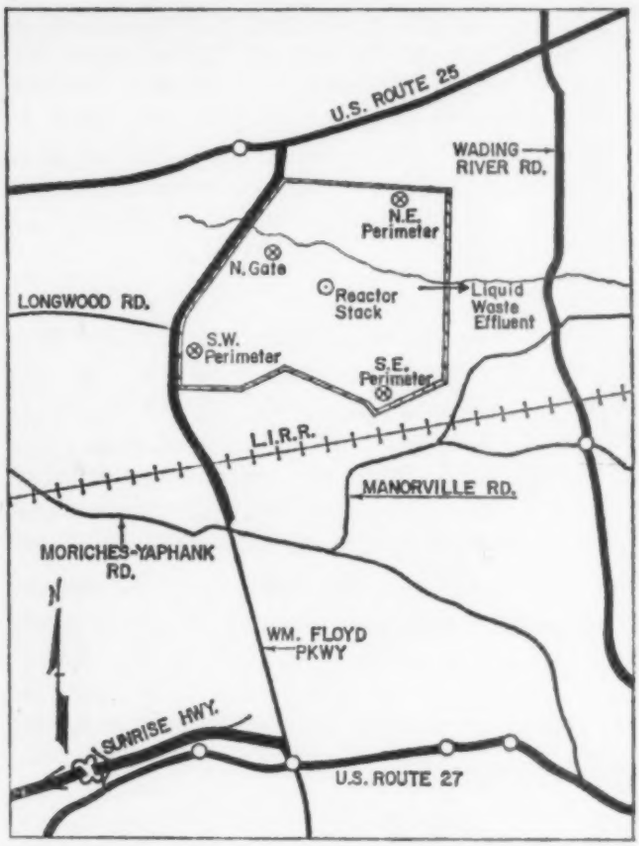


FIGURE 2.—BROOKHAVEN NATIONAL LABORATORY MONITORING STATION LOCATIONS

Air Monitoring

The radioactivity in the discharge coolant air is almost entirely that of argon–41, a beta-gamma emitter. Because the most critical exposure to argon–41 is that of external gamma, the monitoring is performed by measuring the dose-rate in milliroentgens per week (mr/wk) rather than the concentration in air. The environmental maximum permissible dose recommended by NCRP is 0.5 r/yr (10 mr/wk) above natural background, averaged over a one-year period.

Table 2 presents the average external gamma dose rates measured at the four stations shown in figure 2.

TABLE 2.—EXTERNAL GAMMA LEVELS AT BNL SITE BOUNDARY

[Average dose rates in mr/wk]

Period–1962	North gate	Southwest perimeter	Southeast perimeter	Northeast perimeter
Gamma dose from laboratory operations [1]				
January	0.21	0.42	0.51	1.74
February	0.63	0.21	0.77	1.47
March	0.64	0.96	0.86	1.62
April	0.32	0.12	0.84	2.57
May	0.80	0.65	0.24	3.72
June	0.67	0.40	0.26	3.46
Average	0.59	0.48	0.54	2.44
Average dose rate from undisturbed background	3.33	2.89	3.54	3.22

[1] Gamma dose from laboratory operation is due almost entirely to argon-41 from reactor cooling air.

TABLE 3.—GROSS BETA ACTIVITY IN BNL LIQUID WASTE EFFLUENT

Period–1962	Average effluent flow rate (million gallons/day)	Average beta concentration ($\mu\mu$c/liter)	Total beta activity discharged (mc)
January	1.10	100	12.8
February	1.11	120	15.8
March	1.78	80	15.8
April	1.49	60	10.2
May	1.18	80	9.9
June	0.84	150	14.3
Whole period	1.34	90	78.8

Water Monitoring

The BNL liquid waste effluent is monitored for gross beta concentrations at the site boundary. Table 3 presents the average concentration together with the total activity released as determined by using known effluent flow rates.

Previous coverage in *Radiological Health Data:*

Period	Issue
1959 and first quarter 1960	*December 1960*
Second quarter 1960	*February 1961*
Third and fourth quarters 1960	*June 1961*
First and second quarters 1961	*January 1962*
Third and fourth quarters 1961	*June 1962*

ROCKY FLATS PLANT
January–June 1962

Dow Chemical Company, Denver, Colorado

The Rocky Flats Plant (RFP) is engaged in plutonium fuel element fabrication under contract to the Atomic Energy Commission. To assure properly controlled release of radioactive materials to the environment, water, air, and vegetation are sampled periodically and analyzed for gross alpha activity. The most active material involved in the process is plutonium.

Because the plant is located on gravel washed out of the highly mineralized Front Range of the Rocky Mountains, heterogeneous low-level deposits of uranium, thorium, and radium exist in the soil of the area and are measurable in most samples of air, water, and vegetation as well.

Air Monitoring

During the first half of 1962, continuous 24-hour air samples were collected at Coal Creek Canyon, Marshall, Boulder, Lafayette, Broomfield, Wagner School, Golden, Denver, and Westminster. The results are tabulated in table 4. The alpha activity is believed to consist entirely of that of airborne uranium minerals.

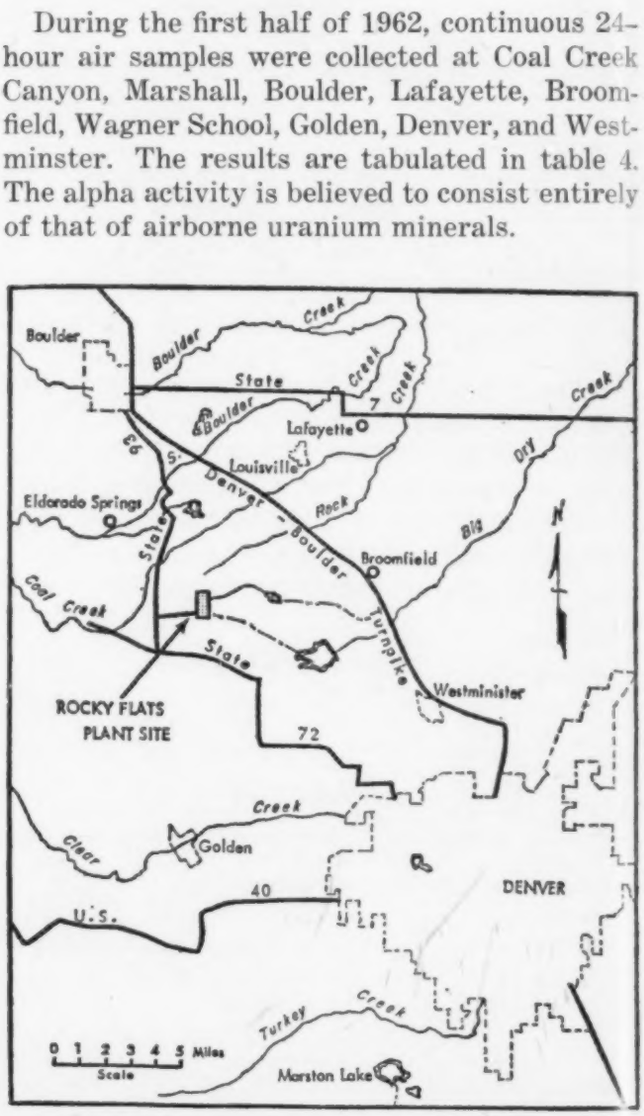


FIGURE 3.—LOCATION OF THE ROCKY FLATS PLANT ENVIRONMENT, DENVER, COLORADO

TABLE 4.—LONG-LIVED ALPHA ACTIVITY IN PARTICULATES IN AIR, RFP

Month (1962)	Average alpha concentration ($\mu\mu c/m^3$)
January	<0.003
February	<0.002
March	<0.005
April	<0.003
May	<0.005
June	<0.005

Water Monitoring

Water samples were collected routinely from four reservoirs at distances ranging from 3 to 8 miles from RFP. The average alpha concentrations in the four reservoirs during the first half of 1962 varied from < 0.7 to 5.8 $\mu\mu c$/liter.

Non-routine raw surface water samples were collected from a number of outlying streams and lakes during fall and spring vegetation collections. Samples analyzed during the first half of 1962 included 20 fall 1961 samples and 9 spring 1962 samples whose average concentrations of unidentified alpha activity were < 1.0 and < 0.6 $\mu\mu c$/liter respectively.

Vegetation Samples

A total of 94 vegetation samples collected during 1961 were analyzed for gross alpha activity during the first half of 1962. The average concentration for 65 samples collected less than 3 miles from the plant was 101 $\mu\mu c$/kg dry weight. The 29 samples collected from 3 to 18 miles from the plant had an average concentration of 117 $\mu\mu c$/kg.

NEVADA TEST SITE DETONATIONS SURVEILLANCE

The July 1962 issue of *Radiological Health Data* carried (on page ii) a brief advance report from the Atomic Energy Commission noting that a low yield nuclear detonation in a tunnel chamber at the Commission's Nevada Test Site on June 13 was not fully contained underground. Gases vented from the top and face of the mesa and through the tunnel portal. Supplemental information and data recently received on offsite exposures from the June 13 detonation indicate that the cloud reached an altitude of 10,500 feet above mean sea level at about six minutes after detonation. As the cloud moved northward, it was tracked both by an airborne monitor and by ground mobile monitors. Offsite monitoring was performed by U.S. Public Health Service personnel under an agreement with the U.S. Atomic Energy Commission.

The maximum dose rate reading at any populated area was at Nyala, Nevada, where the peak reading during the passage of the cloud was 100 milliroentgens per hour. Table 5 presents exposures to the general population. These values are based on film badge readings (corrected for background radiation).

TABLE 5.—MEASUREMENTS OF EXPOSURE DUE TO TEST OF JUNE 13, 1962

Case	Location	Azimuth (degrees)	Distance (miles)	Dose (mr)
1	Diablo	8	50	33
2	Fallini's Range	0	67	23
3	Nyala	19	75	108
4	Nyala	19	75	233
5	Nyala	19	75	203
6	Casey's Ranch	23	77	58
7	Locke's on Hwy. 6	14	95	48
8	Jim Sharp's Blue Eagle	21	97	48
9	Jim Sharp's Blue Eagle	21	97	58
10	Jim Sharp's Blue Eagle	21	97	38
11	Jim Sharp's Blue Eagle	21	97	33
12	Roy Sharp's Blue Eagle	21	100	83
13	Roy Sharp's Blue Eagle	21	100	73
14	Roy Sharp's Blue Eagle	21	100	38
15	Manzoni Ranch	21	114	58
16	Manzoni Ranch	21	114	58
17	Manzoni Ranch	21	114	73
18	Manzoni Ranch	21	114	93
19	4 miles N. of Currant	21	115	83
20	Currant Maintenance Station	22	119	58
21	Currant Maintenance Station	22	119	38

REPORTED NUCLEAR DETONATIONS, DECEMBER 1962

Nuclear detonations reported by the Atomic Energy Commission for December 1962 are listed in table 1. Attention is called to the table footnotes which apply to previously published summaries and define the relative yield ranges of the tests. A departure from the numbering system was necessary in December because AEC did not announce a specific number of tests conducted by the U.S.S.R. between December 23 and December 25. Since AEC has indicated that at least one test was conducted on each of these dates, numbers 69–71 were arbitrarily assigned by *Radiological Health Data* for convenience in referring to the U.S.S.R. detonations reported for December.

Readers reviewing previous issues of *RHD* for nuclear detonations should note the corrections, published in the October and November 1962 issues, to the numerical listings of detonations.

TABLE 1.—SUMMARY OF NUCLEAR DETONATIONS REPORTED DURING DECEMBER 1962

Test number	Location	Date (1962)	Yield range[1]	Type of test
REPORTED U.S.S.R. DETONATIONS[2]				
65	Novaya Zemlya	December 18	Intermediate	Atmospheric
66	Novaya Zemlya	18	Intermediate	Atmospheric
67	Novaya Zemlya	20	Low	Atmospheric
68	Novaya Zemlya	22	Intermediate	Atmospheric
[3] 69	Novaya Zemlya	23	Low[3]	Atmospheric
[3] 70	Novaya Zemlya	24	20 megatons	Atmospheric
[3] 71	Novaya Zemlya	25	"A few megatons"[3]	Atmospheric
REPORTED U.S. DETONATIONS				
[4] —	Nevada Test Site	December 7	Low	Underground
96	Nevada Test Site	12	Low	Underground
97	Nevada Test Site	12	Low	Underground

[1] Low yield range has been announced as less than 20 kilotons yield; intermediate yield is in the range of 20 kilotons up to 1 megaton; and low megaton yield is in the range from 1 to several megatons.

[2] Only specifically announced tests, beginning in the fall of 1961, are included. The Atomic Energy Commission has advised that approximately 50 tests were conducted by the U.S.S.R. from September 1 through November 4, 1961, but only 31 specific Soviet tests were announced during that period. The Commission has also reported that the U.S.S.R. conducted more tests than specifically announced in the August-December 1962 period. Among the "Reported U.S. Detonations," tabulated since the fall of 1961, are two Plowshare Program tests designed to develop peaceful uses for nuclear explosives.

[3] Unspecified number of tests (at least one per day) conducted during December 23–25, the largest of which was 20 megatons detonated on December 24; the magnitudes of the other tests varied from the low yield range up to a few megatons.

[4] British nuclear device test conducted under the "Agreement for Cooperation on the Uses of Atomic Energy for Mutual Defense Purposes." One previous test conducted under this agreement on March 1, 1962 was reported in the September 1962 *RHD*. These two tests are not included among the numbered U.S. tests.

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UNITS AND EQUIVALENTS

For the convenience of the *Radiological Health Data* (*RHD*) reader a selected list of units and equivalents is presented below.

Symbol	Name	Equivalent
Bev	billion electron volts	
cpm	count per minute	
dpm	disintegration per minute	
g	gram	
kg	kilogram	1 kg = 1000 gm = 2.2 pounds
km^2	square kilometer	
kvp	kilovolt peak	
m^3	cubic meter	1 m^3 = 1000 liters
ma	milliampere	
mas	milliampere-second	
Mev	million electron volts	
mi^2	square mile	
ml	milliliter	
mm	millimeter	precipitation: $\text{mm} = \frac{\text{m}\mu\text{c/m}^2}{\mu\text{c/liter}} \times 1000 = \frac{\text{liter}}{\text{m}^2}$
mrad	millirad	
mrem	millirem	
mr/hr	milliroentgen per hour	
mμc	millimicrocurie	1 mμc = 1 nc
nc	nanocurie	1 nc = 1000 pc = 1 mμc = 10^{-9} curies
nc/m^2	nanocurie per square meter	1 nc/m^2 = 1 $m\mu c/m^2$ = 1,000 $\mu c/m^2$ = 1 mc/km^2 = 2.59 mc/mi^2
pc	picocurie	1 pc = 1 $\mu\mu$c = 10^{-12} curies
r	roentgen	
$\mu\mu$c	micromicrocurie	1 $\mu\mu$c = 2.22 dpm

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